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S. GRAHAM BRADE-BIRKS, M.Sc. (Manc.), D.Sc. (Lond.), F.Z.S.

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EDITORIAL

THERE is no difficulty, from a perusal of the pages of this *Report* number of the *Journal*, in realising the great importance of the Research and Advisory Work done by the College in the Session 1931-2. While the literature quoted may prove useful for reference, we may add that in many cases further details of work mentioned in this report are often available and may be obtained from the Heads of the Departments concerned. Moreover, in some instances research papers dealing with matters included in these reports will appear in the *Research* number of the *Journal* which will be published on 12 July 1933.

Mr. H. Martin has again been kind enough to prepare the index for this issue and we express our best thanks to him for this useful piece of work.

S. GRAHAM BRADE-BIRKS.

CONTENTS

DEPARTMENT OF ENTOMOLOGY

By S. G. JARY and M. D. AUSTIN.

ADVISORY WORK. Upwards of 120 enquiries for advice have been dealt with by letter and telephone and a very large number personally on the occasion of visits to farms and orchards. This represents a very substantial increase on last year and reflects the greater interest taken, especially by fruit growers, in dealing with the suppression of insect pests. The County Agricultural and Horticultural staffs in the Province have sent in many of these enquiries and have also supplied information regarding the relative prevalence of various pests. Enquiries of a horticultural nature continue to predominate, perhaps because there have been few cases of serious damage to agricultural crops. A brief survey of the occurrence of the more important pests is given below.

CEREALS. The slugs *Arion hortensis* and *Agrolimax agrestis* caused considerable damage, especially to wheat in the early months of the year, during very mild weather and Wireworms (*Agriotes* spp.) were also more abundant than usual. Damage of widespread nature occurred, especially among barley crops. The Frit Fly (*Oscinis frit*) and the Goutfly (*Chlorops taeniopus*) on oats and barley respectively, were little in evidence. Leather Jackets (*Tipula* spp.) were also less abundant than last year. No case of damage by the wheat Midges (*Contarinia tritici* and *Sitodiplosis mosellana*) came to light, nor was any damage by Eelworms (*Tylenchus* spp.) reported.

POTATOES. Some severe attacks by Wireworm (*Agriotes* spp.) occurred in North Kent. The "seed" tubers were badly holed and the shoots in some cases destroyed. On allotments in Sussex and farms where intensive cropping is practised in Surrey, the Eelworm (*Heterodera schachtii*) was abundant and associated with crop failures of a more or less severe nature. The Capsid Bugs (*Calocoris norvegicus* and *Lygus pabulinus*) have not been present in more than normal numbers.

PULSE AND CLOVERS. The Bean Aphis (*Aphis rumicis*) occurred commonly with local heavy infestations, especially on runner beans. Peas were widely attacked by the Pea Thrips (*Frankliniella robusta*), and damage was more severe on later varieties than on those sown earlier. The Midge (*Contarinia pisi*) was reported as serious from one locality in Sussex, larvae being common in the terminal leaves and causing stunting of the growth. A failure of culinary peas, associated with an attack by the Eelworm (*Heterodera schachtii*) was noted and volunteer plants of potatoes, growing in the same row were apparently free, a somewhat curious circumstance. The Weevils (*Sitona* spp.) were common but not unduly destructive.

MANGOLDS AND SUGAR BEET. Apart from some damage by the larvae of the Cockchafer (*Melolontha vulgaris*) in Surrey, no great damage was noted. The Pigmy Mangold Beetle (*Atomaria linearis*) and the Mangold Fly (*Pegomyia betae*) were scarce. No attacks of serious intensity by the Bean Aphis (*Aphis rumicis*) were observed, though small colonies, as usual, became established.

BRASSICAE. The Flea Beetles (*Phyllotreta* spp. and *Plectroscelis concinna*) were of normal occurrence and not so severe as is often the case. Similarly attacks by the

Cabbage Root Fly (*Chortophila brassicae*) were not serious. The outstanding pests were the Cabbage White Butterflies (*Pieris brassicae* and *P. rapae*). These were more numerous in places than for many years. In the coastal districts of North Kent and Sussex the leaves of many crops were completely skeletonized. The Diamond Back Moth (*Plutella maculipennis*) threatened to develop seriously, but there appears to have been a heavy mortality of the larvae due to occasional thunderstorms with rain and the damage was eventually slight. *Brevicoryne brassicae*, the Mealy Cabbage Aphis, similarly threatened to become epidemic during the hot spell early in the summer, but very heavy parasitism kept it in check.

OTHER VEGETABLES. Carrot Fly (*Psila rosae*) and Onion Fly (*Hylemyia antiqua*) were not reported as serious anywhere, though they occurred as usual in many places. Celery Fly (*Acidia heraclei*), though not abundant in some districts, became very prevalent in parts of Sussex and damage much above the average was caused. An Aphis (*Cavariella* spp.) on Carrots was heavily parasitized and almost every individual in most colonies was thus destroyed.

MUSHROOMS. This crop, of great local importance in the province, suffers from attacks by many insects about which little is known. Further reference is made to work on this subject, which is being carried on by Mr. Austin. The most widespread attacks are due to flies of the genus *Sciara* which have caused almost total losses of crop in places. Other flies of the genera *Phora* and *Drosophila* have been bred from mushrooms, while mites of several species and various Springtails (*Collembola*) are frequently present.

FRUIT. The Capsid Bugs (*Plesiocoris rugicollis* and *Lygus pabulinus*) were, as usual, common on apples and currants. The latter species has usually been regarded as of doubtful significance as far as the marking of apple fruits is concerned, but it has now been found, in at least one orchard where marked fruits were common and where *Plesiocoris rugicollis* could not be found. The immature *Lygus pabulinus* was moreover frequently found in clusters of small apples which showed characteristic capsid markings. The Apple Blossom Weevil (*Anthonomous pomorum*), though rather less severe in general than last year, was still severe locally and the related species (*Anthonomous cinctus*) was again found in a few orchards where it is known to occur. Attacks by the Apple Fruit Sawfly (*Hoplocampa testudinea*) were again heavy, especially on some dessert varieties of apples but the Codlin Moth (*Cydia pomonella*) was only occasionally noted. Aphides in general were of little account. So effectively are they controlled by winter washes that, as with the Apple Sucker (*Psylla mali*) it is difficult to estimate their relative prevalence. The Rosy Apple Aphis (*Anuraphis roseus*) occurred in places on apple and the closely related *Anuraphis crategei* was also seen. The Leaf-curling Plum Aphis (*Anuraphis padi*) occurred spasmodically, where winter washing was not thoroughly carried out. Some growers complain that this species and *A. roseus* are not killed so readily by Tar Oil washes as was formerly the case. There is no reason to believe that this suggestion ought seriously to be considered ; it is probable that some modification in the composition of washes may explain the matter, since it is only with certain washes that the failure is apparent. On both apple and plums, the fruit tree " Red Spider " (*Oligonychus ulmi*) was common and infestations developed to a serious extent early in the summer ; the variety Lane's Prince Albert was particularly susceptible. *Byturus tomentosus*, the Raspberry and Loganberry Beetle, was again common and occurred to a serious extent on cultivated blackberries as well. An early attack by the adult beetles boring holes

into the unopened buds of raspberries was noteworthy. Winter Moth Caterpillar attacks were of no great severity and the larvae of various leaf-eating Tortricids were about normal in numbers. A local attack on apples by the larvae of the Apple Fruit Miner (*Argyresthia conjugella*) near Canterbury was particularly serious. This pest is of spasmodic occurrence in England and in the south, rather scarce. Its normal host appears to be the Mountain Ash (*Sorbus* (*Pyrus*) *aucuparia*) which is abundant in the woods near the affected orchards. A total loss of crop occurred on some varieties, especially near woodland. The attack at a distance of a few hundred yards from mountain ash trees was negligible. In Sussex the Strawberry Blossom Weevil (*Anthonomous rubi*) was a severe pest and more than fifty per cent of the blossom buds were again destroyed in places. In co-operation with the county horticultural superintendent, Mr. G. C. Johnson, control experiments have been laid down. The Apple Twig Cutter (*Rhynchites coeruleus*) did much harm to young apple trees in Sussex and so affected the leading shoots as to spoil the growth of the trees. This insect was also noted commonly in Kent, but was not of great importance. *Rhynchites aequatus* also caused some damage to young apples by puncturing the fruitlets in Kent. On apples and to a greater extent on plums, the Leaf Eating Weevils (*Phyllobius oblongus* and *Phyllobius pyri*) were abundant and did much damage to buds, especially on worked stocks and grafts. The Woolly Aphis (*Eriosoma lanigerum*), though not severe, was widespread. Infestation appeared rather early in the year but colonies did not increase as rapidly as in some seasons. Wasps (*Vespa* spp.), which were plentiful, did little harm to fruit in general. On cultivated blackberries, the midge (*Contarinia rubicola*) was common and in one locality seriously reduced the crop by destroying the blossoms.

HOPS. The Hop-Damson Aphis (*Phorodon humuli*) was widespread and persistent, necessitating several sprayings to control the attacks. A severe outbreak of the Hop Red Spider (*Tetranychus altheae*) occurred in Sussex and the crop was not worth picking. The needle-nosed Hop Bug (*Calocoris fulvomaculatus*), and the Frog-fly (*Euacanthus interruptus*) caused damage in a " poled " garden in Kent.

FLOWERS. The Capsid Bug (*Lygus pratensis*) was common on chrysanthemums in most districts, but not so harmful as in some seasons. Attacks were locally severe. Chrysanthemum Eelworm (*Aphelenchus ritzema-bozi*) was plentiful. An interesting aphis occurred on chrysanthemums at Worthing. This species (*Macrosiphum tanaceticolum*) was described by Theobald (*British Aphididae*) from slides in the British Museum dated 1875, and it had apparently not been known in England since that date. Its normal host plant is Tansy, and it was not known to occur on chrysanthemums.

MISCELLANEOUS. Among the more interesting insects sent for identification as causing damage, the following may be recorded: the beetle (*Ptinus tectus*) infesting oatmeal, the Death Watch Beetle (*Xestobium rufovillosum*) from the roof of a church at Birchington, the mite (*Aleurobius farinae*) infesting stored rape seed, the beetle (*Dermestes lardarius*) which occurred in numbers in stored wool at Chichester, and a midge (*Contarinia corylina*) causing a gall-like growth of the male catkins of cob nuts.

GENERAL OBSERVATIONS.

A greatly enhanced interest in spraying has been shown by fruit growers. In many instances very complete programmes have been carried out and on the whole, insect

damage well controlled. A notable feature is the reduction in amount of fruit marked by the Apple Capsid Bug. Similarly control measures against the Loganberry Beetle were almost everywhere employed with success. Severe insect infestations were the exception, the most notable being the extraordinary prevalence of the Cabbage White Butterflies and the outbreak of the Apple Fruit Miner locally near Canterbury.

EXPERIMENTAL WORK.

1. THE LIFE HISTORY AND CONTROL OF THE STRAWBERRY BLOSSOM WEEVIL (*Anthonomous rubi* Herbst).

Continuing the work on which a preliminary note was published last year, the full details of the life history of this weevil have now been worked out, in relation to cultivated strawberries. It has also been bred from a number of wild plants, found to be attacked in the field. Work on control methods has been done both in the laboratory and in the field. In the latter case, two arsenical dusts were used and in the laboratory the same dusts, together with Pyrethrum preparations and Barium silicofluoride.

2. THE OVICIDAL ACTION OF VARIOUS OIL EMULSIONS AS WINTER WASHES.

In co-operation with Mr. H. Martin of the Chemical Research Department, this work has been continued on the lines of that carried out last year. A suitable laboratory technique for testing small quantities of the emulsions on the eggs of the Capsid Bug (*Lygus pabulinus*) in red currant twigs, has been evolved. The object of these trials was to obtain information on the effect of oils of widely differing specifications, in order to ascertain whether or not ovicidal power could be correlated with any particular characteristic, e.g. viscosity. In addition to the laboratory trials, which involved the treatment of some three thousand twigs, five large scale field trials were carried out, three on apples and two on currants. One of the apple trials was carried out in co-operation with Mr. W. Steer of the East Malling Research Station. The washes used were home prepared, from oils of known characteristics. Very encouraging results were obtained and one grower intends to use the wash commercially during the coming winter.

3. SOME NEW INSECTICIDES AND POSSIBLE INSECTICIDE-FUNGICIDE COMBINATIONS.

Mr. H. Martin has also co-operated in this work, which has included laboratory and field trials. Rotenone and Pyrethrins, two proprietary nicotine substitutes and a recently discovered plant alkaloid, anabasine, were used at various concentrations. The Hop-Damson Aphis (*Phorodon humuli*) was used as the test insect. In the field, combinations of various contact insecticides with Bordeaux mixture were employed, with the object of obtaining information on the possibilities of evolving successful combination washes, to effect a reduction in the number of applications which now have to be made annually on fruit trees. At certain periods the critical time for applying insecticides and fungicides is very limited, notably immediately after the blossoming of apples when applications for Apple Fruit Sawfly, Apple Capsid Bug and Apple Scab fungus almost coincide. Apple Fruit Sawfly was chosen as the test insect, and contact insecticides, incorporated with modified Bordeaux mixtures, were employed. The washes were all applied heavily, in the usual manner of contact insecticides. An account of this work has been accepted for publication.

4. Pyrethrum.

The half-acre experimental plot of pyrethrum was again cultivated and the crop harvested and dried. This is the third year in which a crop has been taken from the plot.

5. Insect and Allied Pests of Mushrooms.

This represents preliminary work on a new subject and Mr. M. D. Austin is primarily responsible for it. The fauna of mushroom beds has been studied in order to ascertain to what extent the pests are introduced in the manure. Supplies of attacked mushrooms have been obtained and the insects and other pests bred out. It has become apparent that the most widespread trouble is due to flies of the genus *Sciara*, and work has largely centred round this group. Mushrooms have been grown in a cellar for the purpose of laboratory observations on the habits of the flies and also for testing out various insecticides for their effect on the mushrooms themselves.

6. Observations on Certain Capsid Bugs.

The biology of the Tarnished Plant Bug (*Lygus pratensis*), as it occurs on chrysanthemums has been further studied and a description of its life history and control methods has been published. Further observations on the oviposition of *Calocoris norvegicus* and *Lygus pabulinus* have also been made. Mr. Austin has been concerned with this work, as part of his general observations on the biology of capsid bugs.

EDUCATIONAL WORK.

Lectures in College.

A complete course of lectures on economic entomology has been given to both agricultural and horticultural students as part of their curriculum. Two students completing their final year for the College Diploma in Entomology have been accommodated in the laboratory and have received an advanced course of lectures and practical work.

Extra Mural Lectures.

Fourteen lectures on entomological subjects were given to various societies, county N.F.U. branches, etc., twelve of which were in Kent, one in Sussex and one in Surrey.

Exhibits at Shows, etc.

Exhibits were staged at the Kent County Show, Maidstone and the Royal Counties Show at Guildford. At the Imperial Fruit Show, Manchester, a paper was read on Growers' Day on the subject of "Winter Moths." Monthly notes on Insect Pests have been contributed to the *Journal* of the Kent Branch, N.F.U. A spraying demonstration plot at West Farleigh, Kent, was taken over jointly by the Chemical, Mycological and Entomological Departments of the College, the County Horticultural Adviser and a representative of the Ministry of Agriculture. The control measures put into operation on this plot, against insect pests, were kept under observation.

Conferences, etc.

The Annual Conference of Advisory Entomologists which took place at London was attended. Four Provincial Conferences, at East Malling, London, Kent Farm Institute, Borden, and the Sussex Farm Institute, Plumpton, have also been attended. A number

of meetings of the Fruit and Vegetable Committee of the Kent Branch, N.F.U., have been attended and at the request of this Committee, a map showing the present position with regard to the Colorado Beetle infestation in France has been prepared. Every opportunity has been taken to distribute information about this beetle and to acquaint the public in this Province with the action they should take on discovering a suspicious insect.

PUBLICATIONS.

1. Jary, S. G. July 12th, 1932. "THE STRAWBERRY BLOSSOM WEEVIL (*Anthonomous rubi* Herbst)." *Jour. S.E. Agric. Coll.*, No. 30, pp. 171-182.

A detailed account of the life history and bionomics of the weevil is given and a laboratory technique enabling observations to be made on the immature stages is described. The larval and pupal stages are figured together with photographs of typical damage. Control measures are discussed and a bibliography appended.

2. Jary, S. G. July 12th, 1932. "PYRETHRUM." *Jour. S.E. Agric. Coll.*, No. 30, pp. 183-185.

The management of an experimental half-acre plot of Pyrethrum (*Chrysanthemum cinerariaefolium*) is described. Various methods of harvesting and drying are discussed and crop weights given, together with analyses of the Pyrethrin content of the flowers.

3. Jary, S. G. December, 1931. "*Macrosiphum tanaceticolum* Kalt. ON CHRYSANTHEMUMS." *The Entomologist's Monthly Magazine*, p. 280.

The occurrence of this rare aphid is recorded for the first time on chrysanthemums. It was described from specimens taken on Tansy (*Tanacetum vulgare*) in 1875 and had apparently not been observed since in this country.

4. Austin, M. D., Jary, S. G., and Martin, H. July 12th, 1932. "STUDIES ON THE OVICIDAL ACTION OF WINTER WASHES; 1931 TRIALS." *Jour. S.E. Agric. Coll.*, No. 30, pp. 63-86.

Laboratory and field experiments with proprietary and home-made ovicidal winter washes are described, with particular reference to their effect on the eggs of the Capsid Bugs (*Plesiocoris rugicollis* and *Lygus pabulinus*). A convenient method for preparing oil emulsions in the field is described as well as a laboratory technique enabling large numbers of oils to be tested. A correlation between the characteristics of certain oils and their biological performance has been attempted.

5. Austin, M. D. May, 1932. "THE OVIPOSITION OF CAPSID BUGS IN FENCE POSTS." *Gardeners' Chron.*, 2369, XCI, pp. 386-387.

An account of the occurrence of the eggs of *Calocoris norvegicus* in fence posts is given.

6. Austin, M. D. September, 1932. "A PRELIMINARY NOTE ON THE TARNISHED PLANT BUG (*Lygus pratensis* Linn.)." *Jour. Royal Hort. Soc.*, LVII, Pt. 2, pp. 312-320.

The biology of this capsid is given with notes on its distribution, oviposition and hibernation. A table of food plants is included. Its economic importance as a pest of chrysanthemums is discussed, together with control measures. *Anthocoris nemorum* is recorded as a predator.

DEPARTMENT OF MYCOLOGY

By Prof. E. S. Salmon and W. M. Ware, M.Sc.

Advisory and Educational Work.

On December 4th we attended a meeting in London of the Association of Economic Biologists and took part in the discussion following the reading of Mr. H. Martin's paper on the value of laboratory methods as a means of testing fungicides. On January 12th a meeting at the Research Station, East Malling, of the Horticultural Section of the Wye Provincial Conference, was attended. On January 13th, at the Hopgrowers' Conference held at Wye College, papers were read by us on the " Hop Downy Mildew, its Life-history and Control." On February 22nd a lecture was given by us " On the Control of Hop Downy Mildew " to the Tonbridge, Paddock Wood, Lamberhurst and Goudhurst branches of the National Farmers' Union. On February 29th and March 1st Prof. E. S. Salmon gave lectures at Worcester and at Hereford on " The Virus Diseases of the Hop " and on " The Hop Downy Mildew and its Control " to the Worcestershire and Herefordshire Hopgrowers' Society. On June 29th a Conference of the Virus Diseases of Plants Committee and Workers was attended at the Research Station, East Malling, and a paper was read on the Mosaic and Chlorotic Diseases of the Hop.

The Conference of Advisory Officers of the Ministry of Agriculture was attended; as also the meetings of the Sub-Committee on Hops of the Research Committee of the Institute of Brewing.

Exhibits of Fungous Diseases of Fruit and Hops were prepared for the Kent Agricultural Show at Maidstone; an exhibit was also sent to the Agricultural Show at Guildford.

On September 6th and 15th, " Visitors' Days," the New Varieties of Hops (raised at Wye College), which are being tested at the Research Station, East Malling, were shown to visitors, and a meeting of the Hops Sub-Committee attended. On September 9th, on the occasion of the visit of the Institute of Brewing to Wye College, plots of certain of the New Varieties were demonstrated.

The following scientists have visited the Department for purposes of consultation and to see the work in progress: M. J. Barthelet, of the Institut de Recherches Agronomiques, Versailles; Dr. E. J. Butler, Imperial Mycologist, and Dr. L. Coleman, Director of Agriculture, Mysore; Dr. M. N. Kamat, from Poona.

Courses of Lectures on Fungous Diseases of Plants have been given by Prof. Salmon to students at the College in the B.Sc. Agriculture, and in the Horticultural Diploma and Certificate Courses, and on Hop Diseases to students taking the course in Hopgrowing. During the winter months a number of lectures have been given by Mr. Ware in towns and villages of Kent.

Among the large number of plant diseases examined the following may be noted: On Wheat *Ophiobolus cariceti* and *Erysiphe graminis*, both causing appreciable damage to the crop; on Barley *Helminthosporium teres* and *Rhyncosporium secalis*,

the latter occurring on the Cambridge new variety B.244 in Thanet. Cases of Club Root (*Plasmodiophora brassicae*) were received from Tunbridge Wells and Willesborough, near Ashford. Several specimens of *Bremia lactucae* on lettuces were received and one of *Marssonina panattoniana*. At Ninfield, Sussex, lettuces were attacked by a bacterial disease (*B. marginale*) affecting the edges of the heart leaves. Lettuces are cut in the morning with the dew on them and are put in sacks and sent to the coast towns. On the following day the hearts are found to be slimy or rotting and the lettuces consequently unfit for sale. On the suggestion by Miss Lacey that the bacteria may be splashed onto the leaves from the soil by rainwater, a preventive method using straw between the rows has been advised. On Asparagus the occurrence of *Zopfia rhizophila* at Woking, Surrey, was noted. After early June, several complaints were received that potatoes had failed to sprout or were growing weakly; no parasitic fungus was found responsible. Hollow Heart of potatoes, a physiological disorder, was received from three different localities. On July 9th, plants of the variety Epicure, a first-early which should have been ready for digging, were received. These were 2 ft. high, vigorous and healthy, but without any crop of tubers. About fifteen allotment holders near Crayford and Bexley who had bought from the same source of "seed" had all failed to obtain any crop. Other varieties on the same allotments were normal. The sprouts had been late in coming through the ground, but the cause of the failure to crop was not found. Potato Blight (*Phytophthora infestans*) was first noticed on July 8th on Eclipse at Horeham Road, Sussex.

A considerable number of diseases affecting apples have been examined during the season. Silver Leaf was met with on only two occasions. In November, in a plantation near Dartford, *Rhizoctonia crocorum* (=*Helicobasidium purpureum*) occurred at ground level around the stems of a number of seven-year-old half-standard trees of Worcester Pearmain. The fungus was of dull purple or brown-purple colour with a white fringe; it was not found on the roots nor could it be traced in the soil around. It was found on the stems of interplanted gooseberry bushes (var. Warrington), which were about eight years old. Here it was present 1 to 2 inches below the soil level and 2½ inches above. It completely encircled the stem and even covered the fork of the lowest main branches. No bad effect was noticed on either apple or gooseberry. In mid-June *Monilia cinerea f. mali*, the cause of Blossom-wilt, was responsible for considerable damage to Allington Pippin and other varieties in East Kent and for almost total loss of the blossom in a large orchard of old trees of Lord Derby at Horsmonden. At the end of August and in September, when the apple crop was about to be picked, several instances of "Eye-rot" were met with. This trouble was specially found in the variety Worcester Pearmain, but occurred also in Lane's Prince Albert. In an orchard at Faversham as many as ten or twelve affected apples were present in each half-bushel of the first picking of Worcesters. This high proportion is probably due to the fact that the infected fruits are usually prematurely coloured. The specimens of Lane's examined were less completely encircled by the disease around the "eye" and the fungus was not producing spores on the surface of the brown area of the skin; cultures were, however, obtained from the tissue beneath which enabled identification to be made. The disease, caused by *Fusarium* sp., was described in an article from this Department in the *Gardeners' Chronicle* of November 6th, 1915. Since that date, *Fusarium Willkommii* Lindau, a stage in the life-history of the Apple Canker Fungus (*Nectria galligena* Bres.) has been identified as the fungus causing "Eye-rot" of Worcester Pearmain. Proof of this is contained in a paper by W. A. R. Dillon-Weston, Notes on the Canker Fungus (*Nectria galligena* Bres.), *Trans. Brit. Myco. Soc.*, XII, pp. 5-12, 1927.

The spotting of apples, attributed to physiological causes, was common in the month of September and a form of injury to Bramley's Seedling and Allington Pippin apples in which depressions occur on the surface of the fruit, was investigated at Bekesbourne, West Farleigh, and Wye. The flesh beneath the depressions was found to be brown and to contain large air cavities. A description of this disease which is attributed to high temperatures probably coupled with conditions of drought, will be published in the *Gardeners' Chronicle.*

The cherry crop in 1932 was below the average, a considerable amount of damage to the blossom having been caused by Brown Rot (*Monilia cinerea*). On May 24th in an orchard at Wye, every truss of blossoms on large trees of Knight's Black were wilted, most of the trusses on *Rivers* and *Elton* and only a few on *Waterloo.* The trees of *Waterloo* were wider spaced. The variety *Amber,* which is later flowering and was only just shedding the petals, was only slightly affected. A leaf disease of cherries was met with in the first week of June, in which brown spots or larger areas occurred on the laminae. *Gloeosporium* sp. developed on the brown areas, the spores measuring $6\mu - 13\mu \times 2{\cdot}5\mu - 4\mu$. The disease resembled that caused by *Asteroma padi* (Klebahn, H., *Zeitschr. f. Pflanzenkr,* 18, 129, 1908) except that the fan-shaped growth of the mycelium below the cuticle was not in evidence. The *Gloeosporium* was found on affected leaves in two orchards at Teynham. Cankers, with " gumming," on the branches of twenty-eight-year-old cherry trees (variety, *Turk*) were sent in from Sittingbourne.

In old cherry orchards at Newington, near Sittingbourne, the gradual death, branch by branch, of several trees which were from fifty to one hundred years old, was investigated. In the third week of October groups of sporophores of *Pholiota squarrosa* (identified by Mr. J. Ramsbottam) were found at the base of about ten per cent of the trees in the orchards. Amber, Turk, Napoleon and Rivers were the varieties concerned. White mycelium but no rhizomorphs was present below the bark. The trees with sporophores were marked for observation of possible spread of the fungus to adjoining trees. *Pholiota squarrosa* is not at present recognized as a fungus parasite on cherry t

The Downy Mildew, *Plasmopara viticola,* again made its appearance on September 13th on leaves of an outdoor vine at Wye. Its occurrence on this same vine in 1926, only the second record of the fungus in England, was described in *Gard. Chron.,* 80, 448-9, 1926. In that year the vine was cut down and burned and has since grown up and become re-infected.

On the cultivated blackberry, variety Himalayan Giant, large Crown Galls of a diameter of about 4 inches were found in September. The fruiting canes trained at a height of 2½ ft. from the ground were affected, the Gall in its growth frequently splitting open the cane.

MUSHROOMS. During the session a considerable amount of advisory work has been carried out relative to various aspects of mushroom-growing. The advisory correspondence increased after Bulletin No. 34 on " Mushroom-Growing " had been published by the Ministry of Agriculture. As mentioned in this *Journal,* No. 29, p. 21, January, 1932, the text of the Bulletin was prepared in this Department ; the first edition dated October, 1931, which was in good demand, was soon sold out and a second edition was called for. This was prepared and published in July, 1932.

The most frequently recurring question, and one most difficult to answer, has been asked by would-be growers who enquire where practical instruction can be obtained ;

these correspondents desire to be put in touch with a successful grower who would be willing to take pupils. Many enquiries have been received relative to the economics of mushroom-growing; information on this subject, however, has not been available. The interest taken by growers in the method of making pure-culture spawn is still alive. Two applications for instruction have been received, one from a grower in Co. Wexford, Irish Free State, who paid a visit to Wye in September, and the other from near Leeds, the enquiry being received through the Advisory Mycologist of that University. In connection with this it is of interest to note that the original grower, who was the first to make pure-culture spawn in this country, is continuing to market his product successfully. An enquiry for samples of spawn was received at the College from the Biologist of the New South Wales Department of Agriculture, Sydney.

The diversity of sites and their adaptation for mushroom-growing have been matters of interest in the course of correspondence or visits. The sites include large chalk caves in Thanet, stone-mines in Northants, an apple store, an oast-house, hoppickers' huts and glasshouses. One grower in Gloucestershire has erected shelving on steel framework in a properly insulated house. Questions have also been dealt with relative to the steam-sterilization of the casing soil for the prevention of the *Mycogone* disease. One nursery was visited where electrical heating of the beds was used.

One or two instances have been of interest as showing that the old type of spawn in " bricks " may be unreliable, because it contains mycelium of unknown origin. In the first, which was brought to our notice through the kindness of Dr. G. H. Pethybridge, a grower in Kent raised by mistake a crop of *Stropharia aeruginosa,* a toadstool of bluish-green colour and of doubtful quality as a food for man. In the second (in Surrey) a crop of deformed and mis-shapen mushrooms were produced in parts of a house spawned with a certain batch of " bricks."

The mushroom diseases and fungus competitors met with in the area have been *Mycogone perniciosa,* which is ubiquitous, *Pseudomonas Tolaasi, Xylaria vaporaria* and *Dactylium dendroides.* Specimens of mushrooms infected with the latter fungus, which was mentioned also in the last report, were received from Mr. D. E. Green, Mycologist to the Royal Horticultural Society. The suspicion that it is to be regarded as parasitic on mushrooms has been strengthened by inoculation experiments in the laboratory.

Cultures of the fungus parasites of mushrooms have been maintained. An account of the *Verticillium,* first investigated in 1929, is being prepared for publication. Assistance has been rendered, in the growing of mushrooms, to the Horticultural Department of the College.

HOPS. A diseased condition of the bine became noticeable from early to late June. The bine on affected plants, which occurred here and there in the garden, sometimes in considerable numbers, was much thinner than normal, and was malformed at the tip, the nodes near the tip being " knotted " and with rudimentary leaves; at lower nodes, the leaves were slightly puckered or crinkled, and of abnormal shape, being three-fid, and shaped something like an Ivy leaf; the margin was frequently not toothed. Specimens were sent in from Kent and Herefordshire, on the Fuggle variety, and the disease was seen also on certain New Varieties in the Hop Nursery. It is possible that the malformations described above may have been caused by low temperature.

During the month of August, branches of hops showing brown discoloration of the petals were received from all the hopgrowing counties. They were sent in order to

obtain an opinion as to whether Downy Mildew was the cause. Although in some few cases this fungus was found responsible, the greater number showed no signs of attack, and the brown colour of the petals was ascribed to the heat of the sun following the wet mists of early morning, a condition which was common during the month. At the beginning of September, the *Botrytis* disease of hop-cones, usually affecting the extreme tip of the cone, was somewhat common.

Two further cases of the Small Hop disease were received in the first week of September, one from Cranbrook in a single hill of a Fuggle garden, and the other from Selling. In both instances the cones were diminutive, being less than half-an-inch in length. The disease was first described in the *Jour. S.E. Agric. Coll.*, No. 26, p. 171, 1929.

RESEARCH WORK.

The following investigations have been made :

1. THE DOWNY MILDEW OF THE HOP (*Pseudoperonospora humuli*). The services of the Department have been constantly requisitioned during the past season. The attacks of Downy Mildew were so severe in the earlier part of the season that fears were rife that in many gardens there would be a shortage of bine. Specimens showing " spiked " growths continued to arrive in large numbers through the spring and early summer months, in particular from growers in Worcestershire and Herefordshire. As the bine approached the top, advice was sought as to the best means of dealing with terminal and lateral spikes and on the various details concerning spraying the bine with home-made Bordeaux mixture. Where intelligent spraying was carried out—and it was estimated that in Kent over eighty per cent of hopgrowers sprayed the crop—the disease was combated with complete success, and a crop of hops free from Downy Mildew was secured. The fight against the disease was helped very materially by the hot, dry summer. A detailed account of the incidence of the disease in the hopgrowing counties will be published shortly, as in previous years. (See 4.)

Some experiments were carried out in the Wye Field hop garden and in the Hop " Nursery " Garden, in which lime or a copper-lime powder was applied to the hills before, or just when, the shoots had started growth. No definite effect on the suppression of the " basal spikes " was observed.

A disquieting feature of the attack of Downy Mildew in hop gardens is the appearance, apparently to an increasing extent, of the spawn (*mycelium*) of the fungus in the " hill," resulting sometimes in the death of the plant. Numerous strap cuts and other parts of the hill showing brown tissues were sent in by growers in the early months of the year. These were invariably found to contain the Downy Mildew spawn. In the " Nursery " Garden hills have been killed outright by Downy Mildew.

2. SPRAYING EXPERIMENTS AGAINST APPLE SCAB. In conjunction with Dr. W. Goodwin, spraying experiments have been continued, for the sixth year, in the College plantation at Wye. Similar plots of Allington and Newton Wonder have been sprayed, respectively, with home-made Bordeaux mixture and an oil-Bordeaux mixture. The crop will be graded by hand, and the results recorded in the *Jour. S.E. Agric. Coll.*

At the request of the Ministry of Agriculture, and in co-operation with them and members of the Kent County Horticultural Staff, a spraying demonstration against

Apple Scab was carried out in an orchard at West Farleigh, near Maidstone. Plots were sprayed with home-made Bordeaux mixture and with Lime-sulphur. Biological observations respecting the incidence of Apple Scab were kept throughout the season. A portion of the crop (amounting in all to 291 bushels) from the sprayed and all the crop from the unsprayed trees was hand-graded to ascertain the amount of Scab present. An account of the results obtained is being prepared for publication.

The results of the spraying experiments at Wye in 1931 have been published (9). The trees of Allington Pippin sprayed three times with home-made Bordeaux mixture gave 25 per cent Scab-affected apples; sprayed with Lime-sulphur (1 : 29 at the pink-bud stage and 1 : 99 in two post-blossom applications), 67 per cent of Scab-affected apples. In the three control (unsprayed) plots the percentages of Scab-affected apples were 99, 93 and 90. The trees of Newton Wonder sprayed three times with home-made Bordeaux mixture gave 49 per cent of Scab-affected apples; sprayed with Lime-sulphur (1 : 29 at the pink-bud stage and 1 : 99 in two post-blossom applications), 97 per cent of Scab-affected apples. In the three control (unsprayed) plots together, the percentage of Scab-affected apples was 99. In all, 3½ tons of apples were graded by hand for Scab. A review of the spraying experiments at Wye for the past five years (1927-1931) has also been published in the same place.

An account has been published (8) of a three years' spraying experiment, on a commercial scale, against Apple Scab, in an orchard at Provender Farm, Norton, near Sittingbourne, belonging to Mr. William Colthup. The varieties sprayed were Worcester Pearmain and Allington Pippin. The three years' spraying experiments showed that a good control of Scab is obtained on both these varieties by three sprayings annually. The increase in the percentage of Scab-free apples over the unsprayed plot varied from year to year as follows: Worcester Pearmain: using Bordeaux mixture, 48 to 57; Bordeaux mixture, followed by Lime-sulphur, 35 to 79; Lime-sulphur alone, 37. Allington Pippin: Bordeaux mixture, 53 to 62; Bordeaux mixture, followed by Lime-sulphur, 64 to 66; Lime-sulphur alone, 48. Evidence was obtained with both varieties that home-made Bordeaux mixture is a more efficient fungicide against Scab than Lime-sulphur. The use of Bordeaux mixture on Worcester Pearmain may, however, cause russeting and discoloration of the fruit to a somewhat serious extent, and where a high finish is required, Lime-sulphur is to be preferred. The use of Bordeaux mixture on Allington Pippin causes no russeting or discoloration of commercial importance and can be strongly recommended.

3. PEAR SCAB (*Venturia pirina*). A new fact in the life-history of a closely-related fungus (*V. inaequalis*, the cause of Apple Scab) was discovered in the spring of 1931 and was mentioned in our last report. This consisted of the overwintering of the fungus on the fruit-bud scales and young prolongations of the spurs. In May, 1932, the same place of hibernation was found in the case of the Pear Scab fungus, and an account of this was published in the following month (6).

The discovery is of some importance in pointing out the origin of early infections and may be of assistance in devising better measures of control. Several varieties of pear were examined in the early part of May, when a heavy infestation by Scab was observed on the blossom-stalks, the sepals, the petals and on the developing fruitlets. By far the most important outcome of this examination was that the variety *Conference* was found to be attacked in the same way as others. The cordon and bush trees of *Conference* grown in the College plantation undoubtedly lost in 1932 a great part of their

blossom which was shrivelled up by Scab. The fungus later attacked the leaves and growing fruit, but never succeeded in doing great damage at this stage; it persisted, however, and the dry, corky scab lesions were visible on a small proportion of the pears when the crop was picked. This variety has always been regarded as immune from or at least highly resistant to Scab and the present tendency towards susceptibility may very well mark the beginning of a complete breakdown of resistance and the enforced adoption of routine spraying to prevent Scab.

Through the kindness of Mr. T. Neame, an opportunity was afforded of making a comparison of the relative efficiency in controlling Pear Scab of Bordeaux mixture and an oil-Bordeaux mixture which had been elaborated by Mr. H. Martin. A plantation, at Macknade, near Faversham, consisting of the varieties *Beurré Hardy* (100 trees), *Louise Bonne* (50 trees), *Beurré d'Amanlis* (50 trees) and *Dr. Jules Guyot* (50 trees), in which spraying had always been carried out but in which Scab had always been in evidence to some extent, was placed at our disposal, together with the necessary labour and spraying tackle. Half of the plantation was sprayed with Bordeaux mixture (8 lb. copper sulphate, 12 lb. hydrated lime, 100 gal. water) and the other half with oil-Bordeaux mixture (4 lb. copper sulphate, 6 lb. hydrated lime, 100 gal. water + 0·75 gal. cotton seed oil); one half of the number of trees of each variety was in each of the plots. Five sprayings were found necessary, viz. two pre-blossom (April 7th, 19th), and three post-blossom (May 17th, June 2nd, 28th). No control trees were left unsprayed, to provide a gauge of the intensity of Scab attack. Both of the spray mixtures were very effective in preventing the disease and no injury resulted except to *Beurré Hardy*, which shed a number of leaves after the third spraying in both plots. On this variety the disease was not so readily suppressed as on the others. It was ascertained that the oil-Bordeaux mixture could be safely applied in very large quantities as a "wash."

4. Virus Diseases of the Hop.

(*a*) *Mosaic Disease.*—A further grant was obtained from the Ministry of Agriculture for the study of this disease, and Mr. D. Mackenzie was again appointed as temporary assistant for six months. Mr. Mackenzie successfully grafted in the Hop-nursery a large number of different varieties of hops, in order to obtain information as to which of these were "carriers" of Mosaic disease. Many of the proved "carriers" were used in the experiments mentioned below in connection with the "Chlorotic disease."

In 1929 healthy hop plants, of a variety (Cobb's) susceptible to Mosaic disease, were planted in pots in soil collected from around the roots of hop plants killed by Mosaic disease. During the period 1929-1932 over one hundred plants have been grown thus, together with the same number of clone-plants (controls) grown in "uncontaminated" soil. No signs of Mosaic disease appeared in any plant. It can safely be concluded, therefore, that under the conditions of the experiment, Mosaic disease is not transmitted through the soil.

Several cases of Mosaic disease have been received from Worcestershire. In one, the disease has led to the grubbing up of four thousand stocks, of which about 50 per cent were infected, in a hopyard of the Mathon variety.

(*b*) *Chlorotic Disease.*—This disease has been studied further, and numerous experiments have been carried out concerning transmission by means of grafting and

"sap." A paper on the subject has been published (5). Further material has been received from hopgrowers in Worcestershire, and three further cases of the occurrence of Chlorotic disease, hitherto known from only one hopyard (of the variety Fuggle) in Worcestershire, have been determined in hopyards in the same county on the varieties Fuggle, Early Bird and Tutsham. Individuals of (symptomless) Mosaic-carriers to which Chlorotic disease had been transmitted by grafting or budding, exhibited eventually marked symptoms of Mosaic disease. A paper on the subject is in the press.

A visit was paid to Worcestershire hopyards to study the conditions under which the present disease has appeared there. It is unknown in other hopgrowing counties. Under the guidance of Mr. C. E. Pearson, of the Ministry of Agriculture, all the farms concerned were visited and the chlorotic hops, or the sites where the disease had occurred, were examined. A disease, apparently of the "aucuba" mosaic type, was discovered on a weed (Black Bryony (*Tamus communis*)) in one hopyard. It may be noted here that at Wye another weed of hop gardens, the Annual Mercury (*Mercurialis annua*) has been found to be affected by a disease apparently of the virus type. Experiments will be carried out to determine whether hops are able to be infected from these and other similarly diseased weeds, such as the Perennial Nettle.

5. IMMUNITY STUDIES. The study of the resistance of varieties of hops to "mould" (*Sphaerotheca humuli*) has been continued. Male plants immune to mould have been discovered among plants obtained from Oregon, U.S.A., and a male plant with the same property has been bred by crossing the "Manitoba Seedling," C9*a*, with an English male hop.

6. FUNGICIDES. In collaboration with the Chemical Research Department, the fungicidal powers of the below-mentioned substances have been investigated with respect to the conidial stage of the Hop Powdery Mildew (*Sphaerotheca humuli*): glyceride oils (crude and refined), alcohols, phenols and copper derivatives. Two further contributions on "The Fungicidal Properties of Certain Spray Fluids" have been published (1), (10). A brief review of these is given by Mr. H. Martin at p. 26.

PUBLICATIONS.

October, 1931 to September, 1932.

1. MARTIN, H., and SALMON, E. S. Oct., 1931. The Fungicidal Properties of certain Spray Fluids, VIII. The fungicidal properties of mineral, tar and vegetable oils. *Jour. Agric. Sci.*, 21, 638-658.
2. WARE, W. M. Oct., 1931. Mushroom Growing. *Bulletin No.* 34, pp. v. + 26, Figs. 8. Ministry of Agriculture and Fisheries, London. (2nd Ed.), July, 1932.
3. SALMON, E. S., and WARE, W. M. Dec., 1931. The Hop Downy Mildew and its Control—Addenda. (Single page supplementary to the 15-page leaflet with above title, Feb., 1931.)
4. SALMON, E. S., and WARE, W. M. Jan., 1932. The Downy Mildew of the Hop in 1931. *Jour. Inst. Brewing*, XXXVIII (N.S. 28), 37-44.
5. SALMON, E. S., and WARE, W. M. Feb., 1932. The Chlorotic Disease of the Hop, II. *Ann. Applied Biol.*, XIX, No. 1, 6-15.

6. SALMON, E. S., and WARE, W. M. June 11th, 1932. Scab on the Spur Wood and Bud Scales of the Pear. *Gard. Chron.*, XCI, No. 2372, 446-447.

7. SALMON, E. S., and WARE, W. M. July 12th, 1932. The Small Hop Disease. *Jour. S.E. Agric. Coll.*, No. 30, 22-27.

8. GOODWIN, W., SALMON, E. S., and WARE, W. M. July 12th, 1932. The Control of Apple Scab on Worcester Pearmain and Allington Pippin: A Three Years' Experiment. *Ibid.*, 28-50.

9. GOODWIN, W., SALMON, E. S., and WARE, W. M. July 12th, 1932. The Control of Apple Scab. Allington Pippin and Newton Wonder. *Ibid.*, 51-62.

10. MARTIN, H., and SALMON, E. S. July, 1932. The Fungicidal Properties of Certain Spray Fluids, IX. The Fungicidal Properties of the Products of Hydrolysis of Sulphur. *Jour. Agric. Sci.*, 22, 595-616.

HOPS

By Prof. E. S. Salmon.

The breeding of new varieties of hops and testing them for resistance to disease and for their commercial value as regards yield, aroma and amount of resins has been continued. As mentioned in the last Report, seedlings have been raised from certain " Manitoba seedlings " (which produce in this country hops as high in preservative value as American hops grown in America) with the object of obtaining, if possible, similar seedlings with an English aroma. Several of these seedlings which fruited for the first time in 1932 hold out promise that this object may be realized. One " Early " seedling, raised from the Bramling crossed with a " Manitoba Seedling " male hop, has shown on analysis a preservative value considerably greater than that possessed by any English commercial variety.

The Fifteenth Report on the Trial of New Varieties of Hops, 1931, at the Research Station, East Malling, has been published (2). Among the chief features of interest are the following: (1) Of the 179 Varieties (New and Commercial) tested, twenty-one cropped at the rate of 20 cwt. to the acre and over. (2) In all the classes (Early, Mid-season and Late varieties) certain New Varieties proved on analysis to be richer in preservative qualities than any of the Commercial Varieties. (3) One of the New Varieties, C9*a* (a " Manitoba seedling ") approached within 0·66 per cent in preservative value the richest foreign (American) hop obtainable. It is very satisfactory to find that in such a wet, cold season as that of 1931 this New Variety is in the same class as the richest American hops. In two previous seasons (1928 and 1929) C9*a* has beaten the richest American hops by 1·52 per cent and 0·83 per cent. It is satisfactory to be able to report that three growers (two in Kent and one in Hampshire) are planting plots of C9*a*.

The arrangements made with two growers in Berkshire and in Kent to secure the growing of a certain New Variety (Y90) in as seedless a condition as possible have been continued and the crop of 1932 has been gathered and dried for analytical purposes.

Under a grant from the Institute of Brewing Mr. A. H. Burgess has continued his investigations on hop drying. With the assistance of Mr. H. Martin and Mr. J. C. Fletcher, chemical analyses of 254 samples of hops and biological tests on twenty-four samples have been made.

A report on work carried out in 1930 and 1931 with the experimental Linhart Type Kiln, erected at Paddock Wood by the Institute of Brewing, has been published (1).

Samples of soil, bines and rootstocks have been taken from the plots on which manuring experiments have been conducted for eleven years at Chilham. These experiments have now been discontinued.

Advice has been given by correspondence and personal visits on problems connected with cultivation, manuring and drying hops.

In conjunction with Dr. Goodwin an experiment is being carried out to determine whether spraying with Bordeaux mixture has any deleterious effect upon wirework.

A further visit was paid to the Research Station of Imperial Chemical Industries at Jealotts Hill, to inspect the grass drying plant in use at that station.

A series of special lectures on Hop Growing was given to students at the College during the spring and summer terms. Lectures on Hop Drying were given at Ledbury, Herefordshire, and at the Hop Conference held at Wye College in January.

PUBLICATIONS.

(1) BURGESS, A. H., 1932. *Jour. Inst. Brewing*, XXXVIII, 226.

(2) SALMON, E. S. August, 1932. Fifteenth Report on the Trial of New Varieties of Hops. (Ashford.)

(3) SALMON, E. S. July, 1932. Report on Hop Investigations at Wye College, 1930-31. *Jour. Inst. Brewing*, XXXVIII (N.S 29), No. 7, 349-350.

HOP RESEARCH SCHEME

Hop Experiments—Wye Field.

By A. H. Burgess.

The experiments upon the time of application of quick acting nitrogenous manure and the time of cessation of deep cultivation, described in the Report for 1929-30, have been continued. The whole garden was manured in late winter with 10 cwt. per acre Superphosphate and 3·6 cwt. per acre Muriate of Potash.

The nitrogenous manure, supplying 290 lb. nitrogen per acre to the Early Birds and Cobbs, and 250 lb. nitrogen per acre to the Canterbury Goldings, was applied as follows:

Early Birds and Cobbs.

Plots M1	34·0 lb. Shoddy	(=30·60 cwt. per acre)
Plots M2	13·65 lb. Sulph. Ammonia	(=12·28 cwt. per acre)
Plots M3 to M7	18·5 lb. Shoddy	(=16·65 cwt. per acre)
	6·25 lb. Sulph. Ammonia	(=5·62 cwt. per acre)

Canterbury Goldings.

Plots M1	29·3 lb. Shoddy	(=26·37 cwt. per acre)
Plots M2	11·91 lb. Sulph. Ammonia	(=10·73 cwt. per acre)
Plots M3 to M7	18·5 lb. Shoddy	(=16·65 cwt. per acre)
	4·50 lb. Sulph. Ammonia	(=4·05 cwt. per acre)

(Shoddy—8·46 per cent Nitrogen; Sulphate of Ammonia—21·13 per cent Nitrogen.)

The Sulphate of Ammonia, as in previous years, was applied in two, three or four dressings and at different stages of growth on the various plots. The stages of growth being: (i) Commencement of growth; (ii) Bines one-third up the strings; (iii) Bines at top of strings; (iv) Pin stage.

Downy Mildew made an early appearance and " spikes " were produced abundantly during May and early June; these were systematically removed, collected and counted, the numbers found are shown in the table opposite.

The Early Birds and Cobbs were affected equally but over three times as many " spikes " were found in the Canterbury Goldings.

Spraying with Bordeaux mixture was commenced on June 6th; this was repeated six times on the Early Birds and seven times on the Cobbs and Canterbury Goldings. The use of " upright " instead of ordinary " umbrella " stringing was found to facilitate spraying with Bordeaux mixture. With hops planted 6½ ft. by 6½ ft. the ordinary umbrella stringing might conceivably lend itself to satisfactory Bordeaux spraying; we found, however, in 1931, that in the case of hops planted 6 ft. by 6 ft. the laterals on one string tended to shield the heads of the bines on neighbouring strings when this system was used.

Downy Mildew "Spikes" removed from Wye Field, 1932.

Early Birds.		Cobbs.		Goldings.	
Date.	No.	Date.	No.	Date.	No.
April 29th	2,300	May 2nd	840	May 3rd	3,400
May 4th	370	May 4th	230	May 5th	420
May 15th	600	May 16th	850	May 17th	2,947
May 19th	650	May 23rd	430	May 20th	1,740
May 24th	234	May 26th	89	May 25th	1,338
May 30th	96	May 30th	138	May 27th	755
June 2nd	166	June 2nd	690	May 31st	856
June 9th	36	June 8th	444	June 4th	2,881
June 16th	181	June 15th	430	June 10th	510
June 22nd	75	June 24th	435	June 13th	1,650
June 27th	38	June 27th	76	June 17th	1,200
July 8th	4	June 29th	64	June 20th	950
				June 24th	150
				June 28th	300
				June 30th	100
				July 7th	83
	4,750		4,716		19,280
"Spikes" per hill	2·094		2·079		7·120

In May a number of M1 plots, which receive no quick-acting nitrogen, were compared with a number of M2 plots, which receive all their nitrogen in a quick-acting form, to find whether these treatments affected the incidence of Downy Mildew differently. Seventy-nine "spikes" were found on twenty-two M1 plots and seventy-five "spikes" on the same number of M2 plots, indicating that these two manurial treatments have no different influence in this respect.

Aphis were somewhat troublesome; the hops were sprayed four times with Nicotine and Soap, and once, just before burr, with powder containing 3 per cent of Nicotine.

Although no Mould was noticed, the garden was sulphured at the rate of 56 lb. per acre, when the hops were in burr, as a precautionary measure.

The crop was picked free from disease of any kind.

The weight of green hops per plot and other details have been recorded.

The crop this year was:

Early Birds	19·57 cwt. per acre.
Cobbs	23·07 cwt. per acre.
Canterbury Goldings	20·54 cwt. per acre.

The following are the total weights of green hops obtained from the different cultivation and manurial treatments in 1931:

EARLY BIRDS.

C3	1,287·9 lb.	M2	1,108·7 lb.
C1	1,284·7 lb.	M4	1,103·6 lb.
C6	1,267·5 lb.	M6	1,098·6 lb.
C5	1,254·4 lb.	M5	1,079·8 lb.
C2	1,237·7 lb.	M3	1,069·0 lb.
C4	1,218·9 lb.	M1	1,059·5 lb.
		M7	1,031·9 lb.

Cobbs.			
C1	1124·6 lb.	M5	931·5 lb.
C1	1078·2 lb.	M3	931·1 lb.
C5	1060·4 lb.	M4	920·2 lb.
C6	1055·3 lb.	M2	915·4 lb.
C2	1027·2 lb.	M7	900·7 lb.
C4	988·1 lb.	M1	889·7 lb.
		M6	845·2 lb.
Canterbury Goldings.			
C5	933·7 lb.	M3	841·7 lb.
C1	925·2 lb.	M5	787·3 lb.
C3	877·7 lb.	M4	775·4 lb.
C2	875·5 lb.	M1	746·7 lb.
C6	865·6 lb.	M6	733·8 lb.
C4	837·9 lb.	M7	730·0 lb.
		M2	700·7 lb.

Cultivation Experiments.

C1 = No deep cultivation.

C2 = Deep cultivation discontinued as soon as possible after spring ploughing.

C3 = Deep cultivation discontinued when bines reach belt.

C4 = Deep cultivation discontinued when bines reach top wire.

C5 = Deep cultivation discontinued when hops are in the "pin" stage.

C6 = Deep cultivation discontinued when bines reach top wire. Ploughed in autumn.

Manuring Experiments.

M1 = No quick-acting nitrogenous manure.

M2 = All nitrogenous manure quick-acting. Times of application A, B, C. (No organic manure.)

M3 = Quick-acting nitrogenous manure in two applications, A, C.

M4 = Quick-acting nitrogenous manure in three applications, A, B, C.

M5 = Quick-acting nitrogenous manure in three applications, A, B, D.

M6 = Quick-acting nitrogenous manure in three applications, A, C, D.

M7 = Quick-acting nitrogenous manure in four applications, A, B, C, D.

Times of application :

A = Commencement of growth.

B = When bine reaches belt.

C = When bine reaches top wire.

D = "Pin" stage.

Plots M1 and M3 to M7 receive organic nitrogenous manure in the winter. All plots receive equal total amounts of nitrogen, phosphate and potash.

The results have not yet been analysed statistically ; it appears, however, that in 1931 the cultivation treatment had some influence on the weight of crop produced ; C4 was least advantageous, C3 was either at or near the top, and C1 came second in each case. The manurial treatments do not show the same agreement.

Three series of samples, each series representing the seven manurial treatments, were examined by a firm of hop merchants who, as in 1930, were unable to distinguish any difference between the samples in each series.

Prof. E. S. Salmon reports:

The 1931 crop from the one hundred hills of the Saaz variety was picked and dried separately. Samples were sent to Dr. R. Muck, Secretary of the Hopgrowers' Association in Saaz (from whom the plants were obtained) for expert opinion as to aroma; his report was as follows: "These hops, according to our views, are coarse and not uniform. They contain an unusually large number of seeds, the 'strig' is coarse and the shape of the hop is very different from the Saaz type, in fact none of the experts to whom I submitted them recognized them as 'Saaz.' As regards the aroma, this was faint and according to the experts (who had no knowledge of the origin of the hops) in no way resembled the 'Saaz' type." A similar opinion was expressed by Mr. C. Gibson Tosswill, of Messrs. Wigan, Richardson & Co., Hop Merchants, London: "Although the aroma is fairly pleasant, we can find no resemblance to the Saaz." The hops, analysed by Mr. Burgess, gave the low preservative value 5·84 per cent. In view of the abnormally wet season of 1931 and its possible effects on this variety, the crop was again picked and dried separately in 1932 and will be submitted to analysis.

As mentioned in last Report, part-pockets of the two New Varieties C9*a* and 411 were purchased in 1931 by a Brewery in Kent, which kindly undertook to carry out trials to ascertain whether these varieties are suitable to take the place of imported American hops. Both varieties have been found, for several years past, to be consistently richer in preservative properties than any English commercial variety. In 1931 these varieties gave the analyses: C9*a*, 10·01 per cent; 411, 8·45 per cent. The report of the Head Brewer was as follows: "With regard to the C9*a*, they gave very pleasing results, especially when used for dry hopping, and it is my belief that if they could be grown commercially as you grew them at Wye, foreign hops, especially American hops, could be dispensed with by those Brewers who are in the habit of using a percentage. These C9*a* hops gave all the flavour of the American hops without any unpleasantness, and so far as we could judge, the keeping value of the beer with the C9*a* hops left nothing to be desired. The 411 hops did not appeal in any way to us. The only flavour we got was not pleasant, and once or twice they made me think of the Tolhursts."

Commercial samples of C9*a* were also sent to a well-known firm of Brewers, who used them for dry hopping two casks of Pale Ale. The samples were sent in March, 1932, and had been kept since October, 1931, at room temperature. The firm wrote: "All the samples are very dry and the hops are broken and chippy and on that account are not really suitable for dry hopping purposes. One, however, was chosen which was rather more whole than the others. The flavour was considered quite pleasant. The report from the Head Brewer on the beer hopped down was not very encouraging: Rough bitter. Lacking delicate flavour that is required from dry hops. In other words not suitable for dry hopping quality beers."

In 1932 pockets, or part-pockets, were obtained from plots of the following New Varieties: C9*a*, 411, R3/100, W107, M35, ON78, Z62 and X35. These have been purchased by a firm in Scotland, which has kindly undertaken to carry out brewing trials, using the hops both for the copper and for dry hopping. A part-pocket of the New Variety OF27 has also been sold to a Brewery in London for a similar purpose.

DEPARTMENT OF ADVISORY CHEMISTRY

By W. Goodwin.

Advisory Work.

The enquiries during the past year have covered a rather wider range of subjects than usual but they fall mainly into two sections (*a*) soils and manures, (*b*) spraying and spray materials. Many of the enquiries have arisen in the course of visits paid to firms in connection with the Fruit Soils Survey. Most of these enquiries were of a routine nature and called for no special treatment but in several cases samples of soil were taken for examination and a fuller report supplied.

An increasing number of samples of soil have been submitted, either through the County Agricultural Organizer's staffs or direct, for the determination of acidity. Some of these samples were from allotment holders or gardeners who sought for information about the use of artificial manures.

Three cases of failure of agricultural crops were found to be associated with a very acid condition of the soil and no other cause could be identified. On the other hand excess of lime was found to be the cause of the dying of rhododendron bushes and a very marked example of lime-induced chlorosis in chrysanthemums was dealt with. In the latter case the careful use of sulphate of ammonia enabled the plants to develop normally.

Serious injury to gooseberry bushes through the improper use of kainit was the subject of one enquiry and the death of rose trees was held to be due, in another case, to the malicious application of paraffin oil.

Water pumped in very large quantities from a colliery was examined in connection with a proposed irrigation scheme. The volume of water, its high temperature and its content of dissolved sodium salts were factors which had to be considered with reference to their effect upon the soil.

Three enquiries as to the value and use of dried poultry manure were dealt with. The extension of poultry-keeping in this area and the shortage of dung—especially for gardens—has led to a greater interest being shown in poultry manure.

Enquiries referring to the preparation or use of Bordeaux mixture in the spraying of fruit or hops were again numerous. Now that the practice of making Bordeaux mixture with commercial hydrated lime has become general, brands, other than those previously examined and found to be suitable, are being offered. Two samples of new makes were received, but neither of them was sufficiently fine to be used in the preparation of Bordeaux mixture, although excellent for manurial purposes.

Serious injury to a hedge growing on the side of the road at Speldhurst was found to be due to a leak of coal gas from the main lying under the road. A similar occurrence was investigated a few years ago at St. Peters, Thanet, where the injury was caused to a crop of oats, the damage being considerable and extending into the field for some distance. Such cases are rare in the country but when a leak occurs under a tarred road the gas is not able to escape until it reaches the margin of the road and it may then penetrate laterally for many yards.

Research Work.

The research work into the chemistry of insecticides and fungicides which has been carried out in this department by Mr. H. Martin, is dealt with in the separate report which follows this one.

Mr. Martin has again co-operated with Mr. Burgess in the biological evaluation of the samples of hops examined under the Institute of Brewing scheme. He has also determined the copper content of ten samples of milk and cream, and the pH of various culture media for the Dairy Bacteriologist, Mr. Barkworth.

Spraying Trials.

In conjunction with the Mycological Department, the spraying trials against Apple Scab were continued in the College plantation on the varieties Newton Wonder and Allington Pippin. The programme in 1932 was again ordinary Bordeaux mixture on plot A, whilst the corresponding plot (B) was sprayed with Bordeaux mixture in which expressed oil of mustard was incorporated. The " oil Bordeaux " was used to ascertain whether it had an equal fungicidal value as it can be applied more rapidly than ordinary Bordeaux mixture and if effective the time required for spraying, and thus the cost, would be reduced. The grading and weighing of the crops from the various plots (the same control plots have been retained) will be done as in previous years. The results of last year's trials were published in the *Journal of the South-Eastern Agricultural College*, No. 29.

A similar trial with Bordeaux mixture and " oil Bordeaux " (cotton-seed oil in this case) was made against Pear Scab on Messrs. F. & T. Neame's farm at Macknade, Faversham. Both of the sprays were reported to have given satisfactory results, but as the crops were not graded it was not possible to make a definite comparison.

Assistance was also given in a spraying demonstration against Apple Scab which was carried out at Court Lodge Farm, West Farleigh, with the aid of a grant made to the College by the Ministry of Agriculture and Fisheries. The demonstration was arranged by the County Adviser in Fruit-growing, Mr. W. G. Kent, who had the advice and assistance of the Advisers in Mycology and Entomology at the College. Mr. J. Turnbull and Mr. C. Davies, Lecturer in Engineering at the College, carried out a series of trials connected with the method of application of the sprays. The crops were graded and counted and the results, which were very satisfactory, will be published shortly. It is hoped to repeat this demonstration in 1933.

At the request of Mr. T. Gates, of Cranbrook, the method of making and applying Bordeaux mixture was shown on a commercial orchard at Flishinghurst, where Apple Scab had caused much loss in previous years. Although there was no comparison with unsprayed trees the results showed strikingly that a high degree of control—placed by the owner at from 90 to 95 per cent—had been obtained, particularly with the varieties Bramley's Seedling and Newton Wonder.

Fruit Soils Survey.

The renewal of the grant made by the Ministry of Agriculture and Fisheries has enabled the survey to be continued for a fourth year and Mr. B. S. Furneaux has again been responsible for the details of the work. The close co-operation with the East Malling Research Station, which has been practised during the whole period of the

survey, suffered a slight interruption owing to the illness of Mr. Bane and his place was taken temporarily by Mr. Bagenal.

The report upon the soils and fruit of the Lower Greensand formation which had been drawn up mainly by Mr. Gethin Jones and Mr. Bane was presented to the Fruit Soils Survey Committee in July and finally to the Ministry of Agriculture. The Ministry has since intimated its willingness to publish the report in a condensed form, on the lines followed with the soil surveys of other fruit-growing areas.

The main area surveyed since last October has been the outcrop of the Hastings Beds in Kent, and a large proportion of the orchards and plantations lying between Wittersham in the east and Capel in the west have been visited. In some parts of this area the acreage of fruit is increasing fairly rapidly.

Sixteen soil series have been established and except in a few cases all the soils so far examined in the High Weald fall into one or other of these groups. Soils derived from Ashdown Sand and Tunbridge Wells Sand under similar conditions have been found to be indistinguishable, and have been included in the same series, as have also the soils on the occasional loamy and sandy strata of the Wadhurst Clay. The clay seams in the Tunbridge Wells Sand, such as the Grinstead Clay and others of less importance, have been included among the soils derived from Wadhurst Clay.

The soils of the Hastings Beds have thus been divided, according to the texture of the geological material, into two main groups. Further sub-division has been introduced so as to differentiate between soils formed *in situ* and those of transported origin. The final separation of the soils into series has been dependent upon their natural drainage.

Special attention has been paid to the water conditions operating in the soils of the High Weald and there seems little doubt that this factor is of great importance in determining the suitability of the soil for any particular crop. The character of the Hastings Beds is such that numerous variations in natural drainage often occur within a small area and it has thus been necessary to apply intensive methods to all the land surveyed.

The results of the joint visits with the pomologists of the East Malling Research Station to the majority of the farms surveyed have not yet been analysed in detail, but they suggest that a good measure of correlation between the soil and the tree performance will be shown.

In so far as has been possible, advice concerning the soil has been given to a number of farmers intending to plant fruit on the High Weald in Kent and in various parts of East Sussex. Visits have also been paid to farms outside the present survey area for advisory purposes ; there appears to be a rapidly increasing demand for service of this kind.

An account of the soils of the High Weald of Kent has been published in the College Journal by Mr. Furneaux (*Jour. S.E. Agric. Coll.*, No. 30, pp. 123-140).

In the course of the survey of the High Weald, and also in other districts, areas have been seen in which fruit trees were evidently suffering from the effects of shortage of potash in the soil. It is well-known that a deficiency of potash may have a very marked effect upon foliage and fruit, leading in some cases to severe leaf scorch and other troubles. Certain varieties of fruit trees are more susceptible than others in this respect,

but the necessity for adequate supplies of potash is recognized in fruit growing and measures taken in the way of manuring to supply them. The application of potash manures does not in many cases give immediate results, but may only be shown after a period of, say, three to five years, even though heavy dressings are given. It is, therefore, very desirable to know whether land which is to be planted with fruit contains what may be regarded as sufficient potash. If the application of potash is deferred until the trees indicate a shortage, then valuable time is lost.

It was decided, therefore, to examine a number of typical High Weald soils for potash and for this purpose to use the *Aspergillus* biological method of Niklas. This method has been shown to give reliable indication of the potash supply in soils growing agricultural crops and it is hoped to apply it to fruit-growing.

As a preliminary test of the *Aspergillus* method a number of Lower Greensand soils collected in the course of the survey and analysed by Mr. Gethin Jones for " available potash " by means of the 1 per cent citric acid solution have been tested. Sufficient data are not yet available to allow of a comparison being made between the two methods themselves and their significance in regard to the potash supply of the soil in fruit growing.

A number of soils of known manurial history have, however, been examined and the method has proved capable of distinguishing sharply between cases where manures containing potash had been applied.

GENERAL.

On the invitation of the Chairman of the Soils Correlation Committee the writer and Mr. Furneaux attended a special meeting of the Committee in December. At this meeting the soil series so far established in the College area were considered.

An exhibit dealing with soaps, spreaders, oil washes, emulsions, etc., was prepared by Mr. Martin and shown at the Kent County Show at Maidstone.

The writer has given two short courses of lectures to the B.Sc. students at the College, the first on the chemistry of sprays and the second on the principles of animal nutrition. Mr. Martin has lectured as usual to the Horticultural Diploma and certificate students on the subject of insecticides and fungicides.

THE CHEMISTRY OF INSECTICIDES AND FUNGICIDES.

By H. Martin.

1. Analysis of Spray Materials.

The number of samples of spray materials received for analysis during the past year was seventy-two, a two-fold increase on the number last year. Most of the samples examined were of materials used in field trials carried out at two other centres or in collaboration with the Research, Entomological and Mycological Departments of this College. The remainder were of proprietary insecticides and fungicides examined at the request of the Advisory Mycologist or Entomologist or because of their frequent use by growers. Noteworthy among these proprietary materials were a number of fungicides intended to replace Bordeaux mixture for the spraying of fruit and hops: (*a*) a green liquid which on addition to water formed a pale green emulsion; the material contained 41 per cent pine oil containing 1·6 per cent cupric oxide in the form of an oil-soluble salt, the emulsifier present was mainly resin soap, for the liquid yielded 37·7 per cent resin. (*b*) a violet-red powder readily soluble in water giving a solution of excellent spreading properties; in addition to an orange-yellow dyestuff the powder contained 13·1 per cent cupric oxide. (*c*) an olive-green paste containing 17·1 per cent cupric oxide in the form of a basic salt which had been ground to a fine state of division in the presence of a protective colloid. (*d*) a strong soap solution containing about 26 per cent fatty acids and 3 per cent cresylic acid. It is of interest to compare the copper concentration of the sprays prepared from these proprietary materials, when mixed in accordance with the maker's instructions, with that of 8 : 8 : 100 Bordeaux mixture; that of the Bordeaux mixture amounts to approximately 2 lb. copper per 100 gallons, that of the proprietary materials is (*a*) 0·4, (*b*) 0·25 and (*c*) 0·4 lb. copper per 100 gallons respectively.

2. The Ovicidal Properties of Oil Sprays.

The examination, in co-operation with the Entomological Department, of the action of hydrocarbon and glyceride oils as ovicides has been continued. The results of the 1931 trials, an account of which was published in the College *Journal* (Publication 4), indicated that, of the representative tar, petroleum and vegetable oils examined, petroleum oils are the most effective ovicides against the capsid *Lygus pabulinus*. Further, it was found that the cheaper semi-refined petroleum oils could be substituted for highly refined oils with neither decrease of ovicidal efficiency nor increase in liability to spray damage. The laboratory trials have therefore been extended to include a wider range of semi-refined oils of known characteristics and, in addition to the investigation of the influence of viscosity, boiling range and degree of refinement on ovicidal properties, attention has been paid to the behaviour of oils of different bases.

Until adequate data have been derived from these laboratory tests, the field trials must be of a somewhat empirical nature. Their purpose in the 1931 season was primarily to determine whether the two-solution oleic acid method devised for the emulsification of the oils was suitable for the preparation of oil sprays in the field. The trials were completely successful in this respect and it is now possible to recommend

the method to those growers who wish to make their own winter washes instead of using proprietary washes which hitherto has been the only alternative. The oleic acid method may, however, fail with abnormally hard waters and, in the 1932 trials, experiments were made of the use of Bordeaux mixture as an emulsifier. Field comparisons of sprays prepared by the oleic acid method and Bordeaux mixture method of emulsification were carried out in collaboration with Mr. W. Steer, of the East Malling Research Station, and the Entomological Department.

Earlier work has shown that ovicidal washes containing semi-refined petroleum oils of the light lubricating type alone are of little use for the control of aphis and psylla and it is of great practical importance that by the addition of a toxic substance the wash be made effective also against the eggs of these insects. In the 1931 field trials, tar oils of characteristics in accordance with the recommendations of the Long Ashton Research Station were incorporated in the washes for this purpose. But as these oils are relatively expensive an examination has been made of the action of the cheaper anthracene oils, of dinitro-*o*-cresol and of a fuel oil of the Diesel type as substitutes for Long Ashton tar oil. The influence of the admixture of these substances on the ovicidal action of the petroleum oils was examined by the laboratory method and by field trials. An account of these field trials, two on black and red currants and four on different varieties of apple, arranged so that the results can be submitted to statistical examination, is being prepared for publication.

3. THE DISCOVERY OF NEW FUNGICIDES FOR THE CONTROL OF POWDERY MILDEWS.

In collaboration with the Mycological Department the investigation of the action of possible new fungicides on the conidial stage of the hop powdery mildew (*Sphaerotheca humuli*) has been continued. In this search for sulphur substitutes, which has now been in progress for three years, attention has been directed mainly to materials able to function as solvents for contact insecticides such as nicotine, rotenone or the pyrethrins. It was for this reason that various oils of mineral or organic origin were first examined and, in the course of this work, an account of which has been published in the *Journal of Agricultural Science* (Publication 1), the pronounced fungicidal action of glyceride oils on the hop powdery mildew was discovered. The principal line of work during the past year has been the utilization of this property and it has been shown that, as suggested in last year's Report, the method of emulsification has a marked effect on the toxic action of the wash. Emulsification by soap or by the two-solution oleic acid method has not proved entirely satisfactory but suitable methods for the preparation of sprays containing glyceride oils have now been evolved and await field trial.

The survey has also been extended to the study of the action of synthetic solvents on the hop powdery mildew and the hop plant. Interesting results have been obtained with hydroxyl derivatives ; aromatic hydroxyl derivatives such as naphthols and oil-soluble esters appear to possess marked fungicidal activity coupled, in many cases, with phytocidal properties ; aliphatic hydroxyl derivatives such as alcohols seem to be relatively harmless to both fungus and leaf. A preliminary account of this work is being prepared for publication.

A detailed examination of the fungicidal properties of those sulphur derivatives which may arise from the hydrolysis of sulphur has been completed and the results published (Publication 5). It has been shown that the fungicidal action of sulphur on the hop powdery mildew is not due to the formation of sulphite, sulphoxylate, hydrosulphite, thiosulphate, or monosulphide sulphur, but that it is due to the formation of

polysulphide sulphur. The action of sodium sulphide solutions on the mildew was shown to be due to the alkalinity of the solutions for equivalent solutions of sodium hydroxide and sodium carbonate have similar fungicidal properties.

4. THE CHEMISTRY OF BORDEAUX MIXTURE.

An account has been published (Publication 2) of the study of the nature of the precipitate of Bordeaux mixture. Previous investigators have found it necessary to postulate the existence of a number of basic copper sulphates but an electrometric examination of the interaction between copper sulphate and calcium hydroxide solutions has shown that the reactions of the Bordeaux precipitate can be explained as the result of the formation of one basic sulphate which, in the presence of excess lime, is converted to the hydroxide. The hydroxide is stabilized by adsorbed sulphate and, by continued washing with water in the absence of carbon dioxide, it is possible to convert the blue hydroxide to a black hydrated cupric oxide. As this change does not take place on the leaf surface, it is suggested that further changes in the composition of the precipitate occur after spraying. The investigation of these changes has, during the past year, been held up by the pressure of other work.

5. THE INCORPORATION OF CONTACT INSECTICIDES WITH COPPER-CONTAINING SPRAYS.

In view of the increasing demand for suitable combinations of protective fungicide and contact insecticide, much work has been carried out on the investigation of possible methods of combining nicotine with Bordeaux mixture. Two of the methods suggested in last year's Report, namely, the Bordeaux-sulphite lye-nicotine spray and the Bordeaux-vegetable oil-nicotine spray, have been subjected to field trials in which the sprays were tested for insecticidal and fungicidal efficiency and for safety to the sprayed plant.

The insecticidal action of the sprays was examined by laboratory and field trials in co-operation with the Entomological Department. An account of the results obtained has been prepared for publication. Tests were also made of certain new contact insecticides which may, in some cases, be substituted with advantage for nicotine. Included in the new insecticides were derivatives of rotenone, the pyrethrins and of anabasine, a recently-discovered alkaloid related chemically to nicotine and identical in structure to neonicotine, a synthetic nicotine substitute.

The fungicidal properties of the modified Bordeaux mixtures were examined by field trials carried out on apple and pear varieties in collaboration with the Mycological Department, and on apple and potato with the help of Mr. Austin of the Entomological Department. Complete results of these trials are not yet available but no case was met of foliage damage as a result of heavy applications of the sprays.

6. THE LABORATORY INVESTIGATION OF PROTECTIVE FUNGICIDES.

Although field trial is essential for the final comparison of the efficiencies of protective fungicides, laboratory methods have been evolved which may yield valuable supplementary information. Protection from fungus attack by the application of protective fungicides is generally the result of the formation of an active fungicide from the deposit left on the plant surface by the spray. One factor concerned in protective fungicidal action is, therefore, the retention of the spray deposit on the foliage and, for the accurate comparison of protective properties, a knowledge is necessary of the amount of deposit throughout the period over which the protectant is effective. In the case of the copper fungicides a technique has been evolved for the estimation of the

quantity of copper remaining on the foliage. Work is in progress on the elaboration of a similar method for use with the sulphur fungicides. In collaboration with Mr. M. H. Moore, of the East Malling Research Station, preliminary work has been carried out on the efficiency of sulphur-containing sprays in the control of Apple Scab. In connection with this work it is necessary to know to what extent differences in fungicidal efficiency are due to factors which concern the retention of spray deposit and to factors which govern the formation of the active fungicide from the deposit. These and other aspects of the laboratory examination of fungicidal dusts and sprays were dealt with in a paper read before the Association of Economic Biologists (Publication 3).

7. SPREADERS.

Extended field trials have been made of sulphite lye, a new spreader described in last year's Report, for general routine use in the orchard spray programme. This work was carried out by the Horticultural Department and gave satisfactory results. Of fifteen samples of sulphite lye, concentrated to paste or powder form, which have been received from various sources both in England and on the Continent, all have been found suitable for use in spray fluids.

An examination has been made of waste products of petroleum oil refining received from three oil refineries with the object of isolating, from the acid and alkali wastes, materials suitable for use as spreaders.

8. BARLEY SEED TREATMENT.

In collaboration with the Agricultural Department a field trial was made of three proprietary seed disinfectants containing organo-mercury derivatives and of one home-prepared disinfectant containing mercuric chloride, on the growth of barley infected with Net Blotch (*Helminthosporium teres*).

An exhibit, conjoint with that of the Entomological Department, illustrating the relationships between composition and ovicidal properties of winter washes was prepared for the Kent County Show at Maidstone.

A translation to Russian of the writer's book, " The Scientific Principles of Plant Protection " has been published by Drs. Filipjev, Petrov and Troitsky and the late Professor A. Jaczewski.

PUBLICATIONS.

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(2) MARTIN, H. 1932. Studies upon the Copper Fungicides. 1. The Interaction of Copper Sulphate and Calcium Hydroxide. *Ann. Appl. Biol.*, XIX, 98-120.

(3) *Idem*, 1932. The Laboratory Examination of Fungicidal Dusts and Sprays. *Ann. Appl. Biol.*, XIX, 263-271.

(4) AUSTIN, M. D., JARY, S. G., and MARTIN, H. July 12th, 1932. Studies on the Ovicidal Action of Winter Washes, 1931 Trials. *Jour. S.E. Agric. Coll.*, No. 30, 63-86.

(5) MARTIN, H., and SALMON, E. S. 1932. The Fungicidal Properties of certain Spray-fluids, IX. The Fungicidal Properties of the Products of Hydrolysis of Sulphur. *Jour. Agric. Sci.*, XXII, 595-616.

DEPARTMENT OF ECONOMICS

By JAMES WYLLIE.

INVESTIGATION INTO FARMING COSTS OF PRODUCTION AND FINANCIAL RESULTS.

This investigation was continued on the same lines as in the previous eight years, the number of farms included remaining about the same. In two cases, departmental accounts have been substituted for detailed cost accounts but their places were filled by two other farms that had just been taken over by young farmers who were anxious to keep complete cost accounts and who were making an attempt to do so before this department got into touch with them. A beginning has also been made with the analysis of the accounts of the College Horticultural and Poultry Departments so that in course of time it will be possible to explore the financial results of these departments in something like the same way as those of the College Farms have already been explored. Two more reports on the results of this investigation have now been published.

Report No. XIII deals with the results from *Hay Crops and Grazing* over the eight years 1924 to 1931.

It was found that the average cost per acre of *meadow hay* up to the time of stacking was about 65s., the average cost per ton about 51s. and the average yield per acre about 25 cwt. The total cost per ton up to the time of feeding was about 60s., compared with an estimated average feeding value during the period in question of about 80s. per ton. In the case of *seeds and clover hay*, the average cost per acre up to the time of stacking was about 125s., the average cost per ton about 80s., and the average yield per acre about 31 cwt. During this period the estimated average feeding value per ton of good seeds and clover hay was about 88s., so that the total cost of production per ton was very much the same as the feeding value.

Emphasis is laid upon the need for considering the quality as well as the quantity of the hay crop. A crop of 20 cwt. per acre of very good meadow hay would appear to have, for many purposes, about the same feeding value as 26 cwt. per acre of good or 44 cwt. per acre of poor meadow hay. In other words, it might be better to grow one ton per acre of very good hay, even if it cost as much as £4 per ton, than two tons per acre of poor hay, even if it cost no more than £2 per ton.

The average cost per acre of grazing was found to be about 37s., but it is emphasized that, taken by itself and without regard to the quality of the pastures, the cost per acre does not mean very much.

In a general discussion of the results, it is shown that the first essential is to maintain a proper balance between hay and grass production on the one hand and live stock on the other. There can be no advantage in growing two blades of grass where only one grew before unless sufficient stock can be provided to eat both blades, whether as grass or as hay, and it is suggested that failure to increase the yield of hay per acre or to improve the grassland is due in many cases to the difficulty, or it may be the

inadvisability, of getting sufficient stock to consume the extra hay or grass produced, rather than to ignorance of how, or mere unwillingness, to do it.

Report No. XIV forms the second in the proposed series dealing with the financial results on the *College Farms* and describes the results obtained from the *Dairy Herd* during the five years 1926-27 to 1930-31, with particular reference to the building up of a tuberculin tested herd. Part I gives a brief account of the general management of the dairy stock and of the results of the tuberculin testing, Part II summarizes the financial results. Tuberculin testing was commenced in October, 1927, when 30 per cent of reactors were found in the sixty-three head of dairy stock tested; at the last test in 1930-31 the herd, both cows and young stock, had a perfectly clean sheet in this respect. The most striking feature of the financial results was the conversion of a loss of 2·46d. per gallon or £6 14s. per cow from the milking herd in 1926-27, into a profit of 4·16d. per gallon, or £11 2s. per cow in 1930-31, and it is shown that each of the various factors concerned contributed towards this improvement: the cost of labour fell by 1·49d. per gallon, of foodstuffs by 1·91d. per gallon, of depreciation on the cows by 1·33d. per gallon, while the average selling price of the milk rose by 1·46d. per gallon. The increased price obtained for the milk was, of course, due to the premium on tuberculin tested milk (Grade A), while the economies effected in the cost of production were partly due to cheaper foodstuffs and partly to a tightening up of the general management.

A complete account is given of the procedure adopted in regard to tuberculin testing and it is emphasized that equally satisfactory results are not likely to be obtained on other farms unless (*a*) all dairy stock, from the age of about one year upwards, are tested six monthly and the reactors rigorously segregated until they can be fitted for the butcher, and (*b*) an extra price of at least fourpence per gallon obtained for the milk. More recent experience has indicated that it may not always be possible to secure such a premium on tuberculin tested milk (Grade A).

With the publication of Report No. XIII one of the original objectives of this investigation has now been reached, namely, to show exactly *how* the costs of production of, and financial results from, any particular farm enterprise can be determined with a reasonable degree of accuracy. It has always been a hindrance to work of this kind that different workers have adopted different methods, with the consequence that the results have not been comparable. Nor has it always been possible for the general reader to discover the basis on which a particular set of financial data has been worked out. In these reports a definite attempt has been made to give as clearly as possible the actual method of arriving at the results and unless this is known the results themselves are almost meaningless, or rather they may be given so many different meanings as to be worse than useless. The word " profit " is heard everywhere and yet there is probably no other English word to which so many different meanings are attached, unless indeed it is the word " cost." One object of these reports, therefore, has been to *define* the various terms used. It is not claimed that the definitions given are the " best," because the same word can be used, with complete relevance, in quite different senses; merely that when, for example, the phrase " average milk yield per cow per annum " is used there should be no manner of doubt as to what it means—actually the so called " herd average " can vary from, say, 700 to 800 gallons, according to the method of computation. It will be agreed that exact and unambiguous terminology lies at the foundation of any kind of scientific investigation. These reports have attempted to give such a terminology for this particular kind of investigation.

FOOD RECORDING SCHEME FOR DAIRY COWS.

This scheme is under the direct charge of Mr. Knox. Two years' work have now been completed and the results circulated to the co-operating farmers. Each farmer has received (*a*) a comparative statement for his own farm for the years 1930-31 and 1931-32, giving the principal results as regards feeding and depreciation on cows and (*b*) a comparative statement showing the principal results on all those farms that could reasonably be included in such a comparison. These statements have been very favourably received and have aroused much interest as to the reasons for the considerable variations shown, not only from farm to farm in the same year, but also from year to year on the same farm. It is quite clear that although conditions differ very widely from farm to farm, making direct comparisons somewhat difficult, if not dangerous, there is nevertheless much to be gained by such comparisons. It is true to say that success in milk production depends largely upon fitting the system to the local conditions, but it must not be assumed that in all cases this objective has been reached, and it is in trying to make the necessary adjustments that comparative statements are likely to be very helpful.

This scheme, being the first of its kind in this country, was originally of an experimental character and considerable time has been spent in discovering not only the most suitable method of collecting the necessary information from farmers but also the best method of tabulating that information so that the results can be presented as free from ambiguity as possible.

Experience under this scheme has confirmed one conclusion from the investigation above mentioned. It is this. Statistical data on farm management are in themselves very interesting but the real value of all this kind of work lies mainly in two directions. First, the fact that the farmer is an *active* co-operator in the work and must make himself responsible for putting down on paper *week by week* most of the important happenings in the milk production enterprise is of great importance—as one farmer put it: he now knows far more about what is going on in the cowsheds than ever he knew before, or would have known but for the weekly reports. Second, the tabulated results provide a sure basis on which the general policy in milk production, not only as a separate enterprise but also in relation to the general farm economy, can be regularly reviewed. For example, the usual practice in Surrey has been for Mr. Knox to visit each farm twice a year *along with* Mr. Mattinson, the Agricultural Organizer, in order to discuss in the fullest and freest possible way the half yearly results as soon as they have been tabulated. It is this regular discussion of the results *on the farm* that is undoubtedly the most essential part of this kind of work from an advisory point of view.

As already intimated, this scheme is being operated in conjunction with the Agricultural Organizers in Kent and Surrey.

STRAWBERRY INVESTIGATION.

So far, the work of the department has been almost entirely confined to ordinary mixed farming. Special crops such as broccoli, strawberries, blackberries, hops, green peas and so on have come under review where they have been included in such farming but no particular attention has been given to fruit farming, market gardening or hop growing. This has been due mainly to the need for concentrating the somewhat limited working strength upon the investigations above mentioned rather than to a belief that there is little room for economic investigation into these special lines of farming.

During the past summer Mr. H. J. Powell has commenced an investigation into *strawberry growing* and it is hoped that this will be followed by similar enquiries into other fruit and market garden crops. Contact has been made with over forty strawberry growers in various parts of Kent and an endeavour has been made to lay a foundation on which more systematic work may be done in the coming year. In a number of cases, very satisfactory data have been obtained regarding the costs and financial results for the 1932 crop but more data will be required before any general conclusions can be drawn.

It is quite clear that a crop like strawberries, which may return anything up to £200 or more per acre, is in quite a different category from a crop like wheat, where the maximum possible return is not more than £15 or £20 per acre. Further a much clearer line can be drawn between the cost of growing and the cost of harvesting and marketing a crop like strawberries and a crop like wheat. In the latter case, the harvesting costs have little or no relation to the yield per acre—a four-quarter crop may in fact cost more to harvest than a six-quarter crop—whereas in the former the cost of picking and marketing is in almost direct proportion to the yield per acre. Hence, a principal object of this investigation is to obtain some reliable data as to the cost of growing strawberries up to the time of picking, under varying conditions of soil, climate, management, etc. Given this basic figure, about which opinions differ rather widely, it would be possible to calculate with considerable accuracy the net returns per acre with varying crop yields and selling prices.

LECTURES.

As in previous years, a course of lectures on agricultural economics was given to all Degree, Diploma and Certificate students and a special course on Research Work in Farm Economics was given to final year Diploma students. The total number of lectures to College students during session 1931-32 was 125. Lectures to farmers were given at Guildford, Sandhurst and Hawkinge and to students at the East Sussex Farm Institute and at Reading University (the Agricultural Club).

STAFF.

No change has been made since the last report.

GENERAL.

This opportunity may be taken to emphasize the scope of the work in which the department is engaged. Apart from lectures, it can be said that the whole efforts have been concentrated upon problems in farm management. Whatever readjustments may be made in the general organization of farming, including of course marketing, there will always be room at the top for the man who takes every possible step to reduce his costs of production to a minimum. Stated paradoxically, this however very often involves not reduced but *increased* expenditure on manures, spraying materials, machinery, wages, and so on. There is ample evidence to show that there is room for more economical production of farm commodities. To some extent, this would follow upon the closer application of certain general principles—for example, milk production could be economized if only producers would get out of the habit of putting all the emphasis on milk yields and of ignoring the costs that have been incurred in getting these yields ; but to a large extent maximum economies can only be worked out after very careful consideration of the particular conditions on each farm. One object of the

department's work is to show how essential it is for each farmer to do a certain amount of figuring. Again and again farmers have expressed surprise at a certain cost being as high (or as low) as it appeared to be from the records—a surprise due to what may be regarded as quite excusable ignorance but which may on the other hand be taken as an indication of a weakness in the business side of farming. There never was a time when the figuring out of things was more necessary than it is to-day : old-established methods have either gone by the board or are being seriously questioned, science has opened up entirely new outlooks for the farm manager, and progressive farmers are everywhere trying out new methods, new implements, new varieties, and even (to them) new crops. It is not so much a question as to whether cost accounts or even simple financial accounts should be kept ; what is implied is that the farmer should get into the habit of putting down on paper a rough estimate of how a certain new venture is likely to work out and of taking the necessary steps to check up the accuracy of his estimate. It is here that records of expenditure and revenue are invaluable and it is the department's object to promote the keeping of such records in every way possible. For fuller discussion of this point, reference may be made to an article in the College *Journal* for 1931 entitled " Some Pointers in Farm Management."

PUBLICATIONS.

The following reports, etc., have been published during the year :—

WYLLIE, J. March, 1932. Investigation into Farming Costs of Production and Financial Results. Report No. XIII—Hay Crops and Grazing—1924 to 1931 (pp. 37-63). [Wye : S.E.A.C.]

WYLLIE, J., and HEWISON, N. V. May, 1932. Financial Results on the College Farms. Report No. XIV—Milk Production over Five Years, 1926-27 to 1930-31 (an example in building up a tuberculin tested herd) (pp. 36-73). [Wye : S.E.A.C.]

WYLLIE, J. 1932. " The Surplus Milk Problem." *Jour. of the Brit. Dairy Farmers' Assoc.*, 1932, 44, pp. 14-26.

WYLLIE, J. 1932. " The Economic Outlook for Agriculture." *Berks. Farmers' Year Book*, 1932, pp. 43-48.

WYLLIE, J. July 12th, 1932. " Some Aspects of Economic Milk Production." *Jour. S.E. Agric. Coll.*, No. 30, pp. 9-21.

VETERINARY DEPARTMENT

By A. D. McEwen, B.Sc., M.R.C.V.S.

Investigations on the diseases of sheep on the Romney Marsh were continued and methods of immunization tested in the laboratory and in the field.

Immunization of sheep against the disease " Struck " which is caused by infection with *B. paludis*, should be undertaken in the winter before the arrival of the season of the year when the disease is most prevalent. Sheep should be re-inoculated each year.

Last season (1932) controlled immunization experiments in the field yielded no definite results on account of the comparative absence of disease.

From the study of this disease over a three year period it is considered that in ordinary seasons the incidence of the disease is low and it is only in the exceptional season that the disease assumes a serious economic aspect. On account of its irregular incidence it is unlikely that preventive measures will ever be generally undertaken. The gravity of this disease has probably been exaggerated.

It has been shown that sheep may be passively immunized against the disease termed " gangrene " and the practice of passive immunization may become popular in the field. The sera which have been used for this purpose were prepared at the laboratory but the absence of suitable accommodation for the maintenance of large experimental animals precludes the thought of continuing this service.

The control of contagious abortion by means of blood testing and segregation continues. Experiments in connection with the use of a live but avirulent strain of *B. abortus* are under way. In the absence of any experimental bovines the avirulence of the strain was tested by inoculating cultures into pregnant cattle belonging to the College herd. These animals were inoculated with the live organism every two months during pregnancy. Those which have calved to date have done so normally without showing evidence of disease. The immunizing properties of the vaccine are being tested on small laboratory animals.

Johnes disease in an acute form was encountered in a large flock of sheep. An opportunity was thus offered to test the diagnostic worth of johnin. Sheep in infected and in non-infected flocks were tested. The results indicated the complete unreliability of johnin as a diagnostic agent.

Funds for sheep disease investigations having ceased, a reorientation of the activities of the Veterinary Department becomes necessary. Experimental work on the larger domestic animals is almost impossible, therefore it is proposed to devote as much attention as possible to poultry. Further reasons for the consideration of poultry diseases are these : (*a*) The great prevalence of disease among this class of stock, and (*b*) the health of poultry is seldom the concern of the practising veterinary surgeon and accordingly it is a legitimate field for the Veterinary Advisory Officer.

PUBLICATIONS.

1. McEwen, A. D. 1932. The Aetiology of the Braxy-like Diseases of Sheep. *Vet. J.*, 180, 192.

2. McEwen, A. D. 1932. Anaerobic Infections of Sheep as seen on the Romney Marsh. *National Vet. Med. Assn. of Great Britain and Ireland 50th Annual Congress*, 1932.

3. McEwen, A. D. 1932. Discussion on *B. welchii* Infections of Animals and Man. *Proc. Roy. Soc. Med.*, 25, No. 6, 811.

4. McEwen, A. D., and Roberts, R. S. 1932. Gas Gangrene in Sheep. Passive Immunization. *J. Comp. Path. and Therap.*, 45, 212.

DAIRY BACTERIOLOGICAL ADVISORY SERVICE

By H. BARKWORTH.

1. ENQUIRIES AND ADVISORY WORK.

(1) Considered in the light of enquiries and advisory work the year has shown considerable expansion. Several cases have come through the agency of some former enquirer. Many farmers and dairymen are, however, quite unaware of the existence of the laboratory. Outbreaks of ropiness were the most prominent feature (five cases). In all, twenty-five cases were visited and nineteen cases dealt with by letter. Eight second or subsequent visits were also made.

(2) The most interesting cases were (i) a certified herd with a milking machine; although everything appeared correct, it was eventually shown that sterilization must be for twenty minutes holding at 210° F. (ii) Trouble due to thermoduric streptococci in a dairy pasteurized local milk. Faulty methods in the dairy were disclosed.

(a) In cases of specific trouble such as ropiness, advice is usually acted on. Producers do not always see eye to eye with the bacteriologist as to the causes, but are usually sufficiently worried to act on faith. In more than one case a letter has subsequently been received gratefully acknowledging the disappearance of the trouble. Indeed, most positive enquirers are ready to try advice. It is cases of general bacteriological uncleanliness that are least susceptible to assistance. Many who will send a sample for analysis have insufficient interest to take action if the result is poor.

(b) Advisory cases have come through several channels; former enquirers have referred others to the laboratory and some cases have come through the County Staffs. A few contacts were made at conferences and shows. Thus one case of ropiness came through a dairyman who attended the Sittingbourne Conference. A large dairy concern was interested in a particular exhibit at the Royal Counties Show and an enquiry from another concern was referred through the Bath and West Show.

2. INTELLIGENCE.

(a) Problems are confined almost exclusively to liquid milk and cover, in addition to milk, such correlated items as mechanical refrigeration and other equipment.

(b) Several new names which appear on the books were referred to the laboratory by a third party, and slowly the existence of the laboratory is becoming known. Many farmers and dairymen are still unaware of the facilities at their disposal.

(c) A survey of the number of senders and the distribution of advisory calls shows that work is not evenly distributed throughout the area. For strictly advisory calls the bacteriologist is always ready to go any distance and the proportion of cases dealt with by letter is reasonably even throughout the area.

		No. of Senders.	*Paid Samples.*	*Advisory Visits.*	*Letters.*
Kent	Farmers ..	40	99	9	8
	Others	12	92	5	—
Surrey	Farmers ..	23	80	6	5
	Others	3	8	1	—
East Sussex	Farmers ..	8	62	2	2
	Others	3	24	—	—
West Sussex	Farmers ..	10	32	1	2
	Others	—	—	—	—

(*d*) The various spells of hot weather brought enquiries on taints, premature souring and ropiness.

3. Investigational Work.

(*a*) See paragraph 1.

(*b*) Simultaneous tests by standard method, Guide 3rd Ed. and by Van Oijen technique were continued; 345 Van Oijen tests were made, using competition and private senders' results for the standard count, and also 144 samples from a local creamery were specially tested to be included in the work. These results are under discussion.

4. The year's total of analysis is as follows:

	Kent	Surrey.	East Sussex.	West Sussex.	Sundry.	Total.	Remarks.
1. (*a*) Competitions ..	—	454	158 (incomplete)	—	—	612	
(*b*) Accredited Schemes	—	—	—	—	—	—	
(*c*) Reading Duplicates	—	—	—	—	—	94	
(*d*) Public Health Authorities ..	—	—	—	—	—	103	For five authorities. Includes Acid fast 87
(*e*) Advisory	65 —	29 —	44 —	3 —	59 3	203 —	Includes Butter 1 Cream 1 Ropy 5 Licences 3
(*f*) Private senders ..	99	80	62	32	124	397	Includes Acid fast 6 Mastitis 28 Ropy 1
(*g*) Others	—	—	—	—	—	144	For research.
2. Chemical		Done by	Chemical	Laborato	ry.		
3. Various	—	—	—	—	—	345	Van Oijen method.

5. Lectures and Demonstrations.

Lectures. The following were given: Internal, two, Dairy Bacteriology. External, one, Natural History Society, Modern Milk Practice.

Conferences. The bacteriologist read a paper at a conference of producers, dairymen and sanitary inspectors, organized by the last-named at Sittingbourne, June 11th, and a clean milk exhibit was also staged.

The following conferences were attended:

A.E.A., December, 1931.

Dairy Bacteriologists' Meeting, July, 1932.

Society of Agricultural Bacteriologists.

Shows. There has been a record demand for exhibition work. Bonus schemes were made a part feature of all displays, which were arranged at

Royal Counties Show, Guildford.

Kent Rural Community Council Fair, Maidstone.

Sussex Agricultural Show, Eastbourne.

Kent Agricultural Show, Maidstone.

Tunbridge Wells Agricultural Show, Tunbridge Wells.

The bacteriologist was in attendance for part of the time at each of the above shows.

The exhibit at Sittingbourne has just been noted, and the bacteriologist took a tour of duty at the Ministry of Agriculture stand at the Ice Cream Convention.

6. CO-OPERATION.

Several cases have been referred to the laboratory by County Staffs and the laboratory has also referred enquirers to the County Staffs. In addition samples covering eight cases were sent to the laboratory by County Staffs.

It is certain that County Staffs—at least in some areas—have been in close touch with the laboratory.

Work for Public Health Authorities has been reduced, probably for reasons of economy.

7. GENERAL.

The total of samples has fallen (2,400 to 1,400), but this is due to two counties having no competition.

The number of private samples has been well maintained (582, this year is 500).

On the other hand, external activities have increased, advisory visits and letters have increased as well as show work.

Several dairymen have been interviewed, at their request, about bonus schemes, though nothing definite has as yet matured. The laboratory has had the benefit of assistance from Mr. Anderson in this matter.

8. PUBLICATION.

BARKWORTH, H. July, 1932. Seven Years' Study of Keeping Quality Tests. *Agric. Progress*, Vol. IX, pp. 93-95.

The method of testing for and recording Keeping Quality is explained, and the weaknesses discussed. After examining the collected results for the past seven years, approximately three thousand samples of morning and afternoon milk, the author concludes that for a given plate count the Keeping Quality varies approximately twelve hours, above or below the expected average. Samples of afternoon milk are found to average nine hours less Keeping Quality than samples of morning milk of similar total count, and there is some discussion on this point.

DEPARTMENT OF AGRICULTURE

By V. R. S. Vickers, V. C. Fishwick, H. B. Bescoby and N. L. Tinley.

FIELD TRIALS, 1931.

The season of 1930-31 was satisfactory for crops, at no period was there a drought and although rain extended over considerable periods, the quantity which fell in the twelve months was normal. The harvesting of corn was difficult owing to the rains in July and August. The sunshine during the summer was below normal. Sugar beet and mangels grew well and good crops resulted, potatoes continued to grow well until a heavy attack of potato disease in July. More detailed meteorological records are given on page 47.

The following trials are recorded :

1. Barley manuring.
2. Sugar beet manuring.
3. Potato varieties.
4. Mangel manuring.
5. Pasture investigation.

1. Barley Manuring.

This trial was designed to test the effect of nitrogenous, phosphatic and potassic manures on the yield and the nitrogen composition of barley grain. The arrangement of plots was in the form of a 4 ×4 Latin Square, each plot being $\frac{1}{80}$ acre, and each of the $\frac{1}{80}$ acre plots was subdivided into four $\frac{1}{320}$ acre plots, thus a complex Latin Square was formed, from which the actions and interactions of the various manures were calculated. The sampling method of harvesting was employed and the grain threshed and analysed at Rothamsted. The nitrogenous manures were calculated in quantities to supply ·2 cwt. of nitrogen per acre, the superphosphate to supply ·4 cwt. of phosphoric acid and the sulphate of potash to supply ·6 cwt. of potash per acre.

Manuring.

Manures.	lb. per acre.	When applied.
Sulphate of ammonia ..	106	March 24th.
Nitrate of soda ..	165	,,
Calcium cyanamide ..	128	,,
Superphosphate ..	250	,,
Sulphate of potash ..	150	,,

The seed Plumage Archer was drilled on March 26th at the rate of 3 bushels per acre and the crop was sampled on August 14th. During growth the nitrate of soda plots appeared the greenest and the no manure plots were thin. The no manure plots changed colour before the manured plots. The corn was not laid, and although the weather was very wet at harvest time, by using the sampling method the grain threshed out in good condition.

I. Yields of Grain in cwt. per acre.

	No nitrogen.	Sulphate of ammonia.	Nitrate of soda.	Calcium cyanamide.
No potash, no super ..	18·39	23·33	24·00	22·36
Sulphate of potash ..	21·62	22·33	24·29	22·27
Superphosphate ..	20·94	24·82	24·77	21·87
Potash and super ..	20·59	23·60	24·86	21·20

Standard error nitrogen treatments .. ·822 cwt. or 3·64 per cent.
Standard error mineral treatments .. ·754 cwt. or 3·34 per cent.

Summary.

The standard errors 3·64 per cent and 3·34 per cent are low and justified the use of the sampling method. The significant difference between yields may be taken as three times the standard errors. The interpretation of these results show that for yields of grain the application of nitrogen in any of the three forms increased the crop, although calcium cyanamide applied in conjunction with mineral manures did not reach significance. There is a distinct tendency for sulphate of ammonia and nitrate of soda applied with superphosphate to give the best results, but the action of the superphosphate is not large enough to give a significant increase. Therefore nitrogen has increased the crop but the addition of the mineral manures is not proved to have been of value.

II. Yields of Straw in cwt. per acre.

	No nitrogen.	Sulphate of ammonia.	Nitrate of soda.	Calcium cyanamide.
No potash, no super ..	18·19	23·90	25·60	22·69
Sulphate of potash ..	21·28	22·59	26·64	22·52
Superphosphate ..	20·13	26·74	28·58	21·20
Potash and super ..	19·48	24·67	27·37	20·39

Standard error nitrogen treatments .. 1·140 cwt. or 4·92 per cent.
Standard error mineral treatments .. 1·319 cwt. or 5·69 per cent.

Summary.

These results conform to those of the grain. The nitrogenous manures increased the yield of straw but the mineral manures have not proved of value ; but again the superphosphate with sulphate of ammonia or nitrate of soda shows a tendency to increase the yield.

III. Nitrogen Content of Grain.

(a) Mean Nitrogen Content.

	Percentage Nitrogen in dry matter.
No nitrogen	1·40
Sulphate of ammonia	1·415
Nitrate of soda	1·46
Calcium cyanamide	1·39

Nitrate of soda shows a slight tendency to increase the nitrogen content.

(*b*) *Mean Mineral Effect.*

	Percentage Nitrogen in dry matter.
No phosphate	1·428
Superphosphate	1·405
No potash	1·425
Sulphate of potash	1·408

Phosphate and potash each tend to lower the nitrogen content.

(*c*) *Combined Mineral Effect.*

	Percentage Nitrogen in dry matter.
Phosphate and potash	1·415
No minerals	1·455

The two minerals applied together gave a distinctly lower nitrogen content.

2. SUGAR BEET MANURING.

The following trials were carried out at the request of Sir John Russell, F.R.S., and the sugar contents of the roots were determined at the Rothamsted Laboratories.

A. The effect of nitrogenous manures on I Yield of roots, II Yield of tops and III Sugar content.

B. The effect of the application of chlorides on I Yield of roots and II Sugar content.

A. The Effect of Nitrogenous Manures.

The trial was laid out in a 4×4 Latin Square with four treatments replicated four times, a total of sixteen plots each $\frac{1}{80}$ acre. The rows were 18 in. apart, the plants 9 in. apart in the rows, and there was a good plant. The crop grew well throughout the season and it was not possible to observe any differences in the growth of the crop due to the treatments.

Manuring.

The basal dressing was 12 tons of farmyard manure, 4 cwt. superphosphate and 2 cwt. muriate of potash per acre.

Manures.	lb. per acre.	When applied.
Sulphate of ammonia	186	May 4th.
Nitrate of soda	288	,,
Calcium cyanamide	224	,,
No nitrogen	—	

The amounts of manure applied were calculated to supply an equivalent amount of nitrogen. The seed " Kleinwanzleben " was drilled at the rate of 19 lb. per acre on May 6th.

I. Weight of Roots in tons per acre.

Manures.	Unwashed.		Washed.
Sulphate of ammonia	16·23		14·86
Nitrate of soda	16·18		14·81
No nitrogen	16·09		14·74
Calcium cyanamide	16·07		14·71
Standard error		0·18	
Significant difference		0·54	

The additional manuring had no effect.

II. Weight of Tops per acre.

Manures.	Tons.
Nitrate of soda	18·67
Calcium cyanamide	17·67
Sulphate of ammonia	17·05
No nitrogen	16·12
Standard error	0·55
Significant difference	1·65

Nitrate of soda definitely increased the yield of tops; sulphate of ammonia and calcium cyanamide also showed a tendency in that direction.

III. Sugar Content.

Manures.	%
No nitrogen	18·93
Nitrate of soda	18·61
Sulphate of ammonia	18·48
Calcium cyanamide	18·39
Standard error	0·087
Significant difference	0·261

The application of nitrogen in any form significantly lowers the sugar content, thus agreeing with the results obtained in many other trials.

B. The Effect of Chloride Manuring.

This trial was laid out in a 4×4 Latin Square, each plot being $\frac{1}{60}$ acre. The variety, amount sown and spacing were the same as for the nitrogen trial. No differences due to the treatments were noticeable between the plots.

Manuring.

The basal dressing was 12 tons of farmyard manure, 4 cwt. of superphosphate and 2 cwt. of sulphate of ammonia.

Manures.	lb. per acre.	When applied.
Muriate of potash	224	May 6th.
Salt	160	,,
Muriate of potash + salt	224 + 160	,,
No chloride	—	

I. Yield of Roots in tons per acre.

Manures.	Unwashed.	Washed.
Salt	15·35	14·14
No chloride	15·16	13·97
Salt + potash	15·07	13·90
Muriate of potash	14·74	13·52
Standard error	0·21	
Significant difference	0·63	

There were no effects from the salt or potash.

II. Sugar Content.

Manures.	%
Muriate + salt	18·99
Muriate of potash	18·68
Salt	18·63
No chloride	18·43
Standard error .. .. 0·15	
Significant difference .. 0·45	

The effect of muriate of potash and salt is not significant but the tendency shown is the one usually observed and sometimes quite significant.

Conclusions.

The application of artificial manures in addition to the farmyard manure was ineffective this season. The field (The Park) usually grows good crops and is evidently in a good state of fertility.

3. POTATO VARIETIES (Main Crop).

The plots, of $\frac{1}{40}$ acre each, were laid out in the form of two 4 × 4 Latin Squares giving eight replications of each variety. The object of the trial was to find the heaviest yielding variety. In 1930 eleven varieties were grown in a preliminary trial and the three varieties giving the largest crop were selected for further trials, using the variety King Edward as a control. The potatoes were planted on April 15th and dug September 30th to October 2nd.

Yields in tons per acre.

	Diseased.	Chats.	Seed.	Ware.	Total.
Arran Consul ..	·11	·35	1·99	9·84	12·29
Arran Banner ..	·35	·37	1·67	8·35	10·74
Seedling 675 ..	·14	·70	2·85	6·79	10·48
King Edward ..	·13	·73	2·72	4·51	8·09
Standard error	·03	·02	·02	·08	·14

Significant difference taken as three times the standard error.

The interpretations of these results shows Arran Consul to be the heaviest cropper with the largest quantity of saleable potatoes. Arran Banner gave a comparatively large yield of potatoes which were diseased, the total crop was nearly the same as the Seedling 675 but the quantity of ware was greater. Seedling 675 showed a large quantity of chats and seed potatoes. King Edward gave a comparatively low yield and many of the tubers were of the chat and seed size. The errors of the experiment are low and both Latin Squares indicate the same results.

4. MANGEL MANURING.

Two trials were carried out :

A. Effect of additional muriate of potash.

B. Effect of top dressing with nitrate of soda and sulphate of ammonia.

A. Effect of additional Muriate of Potash.

The trial was designed in a 4 × 4 Latin Square, the plots being $\frac{1}{40}$ acre each. The rows were 22 in. apart and there was a very good plant. The season was favourable for the growth of the crop and satisfactory yields resulted.

Manuring.

The basal dressing consisted of 12 tons of farmyard manure, 4 cwt. of superphosphate, 1 cwt. of steamed bone flour, 1 cwt. of sulphate of ammonia per acre, applied May 5th.

Manures.	lb. per acre.	When applied.
Muriate of potash ..	224	May 6th.
Muriate of potash ..	280	,,
Muriate of potash ..	336	,,
Muriate of potash + salt	224 + 160	,,

The seed " Golden Tankard " was drilled May 6th on a very good seed bed, and on May 17th the plants were showing above ground.

Weight of Roots in tons per acre.

Manures.		Tons.
2 cwt. muriate of potash + 160 lb. salt ..		26·76
3 cwt. muriate of potash		26·62
2 cwt. muriate of potash		26·10
$2\frac{1}{2}$ cwt. muriate of potash		25·91
Standard error	·54	
Significant difference ..	1·62	

The additional manuring had no effect.

B. Effect of top dressing with Nitrate of Soda and Sulphate of Ammonia.

This trial was laid out in exactly the same way as the muriate of potash trial.

Manuring.

The basal dressing consisted of 12 tons of farmyard manure, 4 cwt. superphosphate, 1 cwt. of steamed bone flour, 2 cwt. muriate of potash and 1 cwt. of sulphate of ammonia.

Manures.	lb. per acre.	When applied.
Nitrate of soda ..	148	June 25th.
Sulphate of ammonia ..	112	,,
Nitrate of soda + sulphate of ammonia ..	74 + 56	,,
No nitrogen	—	

Weight of Roots in tons per acre.

Manures.		Tons.
Sulphate of ammonia		30·37
Nitrate of soda		30·30
Nitrate of soda + sulphate of ammonia ..		29·56
No nitrogen		28·74
Standard error	·46	
Significant difference ..	1·38	

Nitrate of soda and sulphate of ammonia each increased the yield slightly.

Conclusions.

These two trials confirm the result of the sugar beet trial and show that the soil (The Park) was in a good state of fertility and that in this season the application of artificial manures in addition to the farmyard manure was ineffective.

5. PASTURE INVESTIGATION (Brenzett).

The Journal of the South-Eastern Agricultural College, No. 28, July, 1931, contained the weights of grass cut from plots in the seasons 1928-29-30, and these were as follows :

	Weight of grass in tons per acre.		
	1928.	1929.	1930.
Unmanured ..	8·28	6·33	9·70
Manured ..	—	9·01	13·77

The plots were laid down on good fattening land on the Romney Marsh and one plot received a basal manurial dressing in 1929 of 5 tons of ground chalk, 10 cwt. of superphosphate, 2 cwt. of sulphate of potash per acre, during the growing season of 1929 and 1930 the plot received a dressing of ½ cwt. of sulphate of ammonia every three weeks. For the season 1931 the application of sulphate of ammonia was applied every six instead of three weeks. The weights of grass cut were as follows :

Date of cutting.	Weight of grass. Unmanured plot. lb.	oz.	Manured plot. lb.	oz.
May 11th	2	2	2	12
June 1st	4	6	4	10
June 22nd	2	8	2	8
July 13th	1	3	1	2
August 3rd	1	4	1	4
August 24th		8		9
September 14th		12		14
October 5th		4		14
October 26th		7		8
	13	6	15	1

The yield of grass per acre was 7·23 tons from the unmanured plot and 8·14 tons per acre from the manured plot. The increase due to sulphate of ammonia was much less than in the previous years. This lower increase is frequently noticed with the continual use of nitrogenous manures on very small plots.

Conclusions.

From these results it appears that even on the good Romney Marsh pastures the judicious use of artificial manures will still further increase the yearly grass output, which might possibly enable more sheep to be kept per acre. The complete record of grass cut per acre is as follows :

Weight of grass per acre.

	1928.	1929.	1930.	1931.	Average.
Unmanured ..	8·28	6·33	9·70	7·23	7·75
Manured	—	9·01	13·77	8·14	10·31
Increase	—	2·68	4·07	·91	2·56

The average increase was 2·56 tons per acre of grass for a period of three years, and theoretically if eight to ten sheep can be kept on 7·75 tons of grass, ten to thirteen could be kept on 10·31 tons.

FARM RECORDING.

(*a*) Weather Records and the Effects on Crops.

1930. *October.*—Mild and dry except for wet spell 19th-22nd. 2·46 in. of rain were recorded; normal for South-East England, 3·46 in. Six ground frosts were recorded. Sunshine hours, 4·30; normal South-East England, 3·44. Winter barley was drilled on 29th. Monarch wheat drilled 27th and 28th. Potato lifting began on the 3rd. Mangel pulling began on 13th.

November.—Much rain and little sun. 4·95 in rain were recorded; normal South-East England, 3·07 in. Thirteen ground frosts were recorded. Sunshine hours, 2·37; normal South-East England, 2·15. Winter barley above ground on 17th. Wheat above ground on 15th.

December.—Frequent rain, although average for month was below normal. 2·46 in. rain were recorded; normal South-East England, 3·11. Seventeen ground frosts were recorded. Sunshine hours, 1·44; normal South-East England, 1·44.

1931. *January.*—2·23 in. rain were recorded; normal for South-East England, 2·20. Eighteen ground frosts were recorded. Sunshine hours per day, 1·96; normal South-East England, 1·68.

February.—3·06 in. rain were recorded, normal for South-East England, 2·05 in. Nineteen ground frosts were recorded. Sunshine hours per day, 2·71; normal for South-East England, 2·64.

March.—Extremely dry. ·32 in. rain were recorded; normal for South-East England, 2·05 in. Eighteen ground frosts were recorded. Sunshine hours per day, 5·24; normal South-East England, 3·94. Sowing of Marvellous oats and Plumage Archer barley was begun and completed between 14th and 30th.

April.—Wet and comparatively warm. 3·59 in. rain were recorded; normal for South-East England, 1·69 in. Five ground frosts were recorded. Sunshine hours per day, 4·31; normal South-East England, 5·65 hours. Potatoes planted between the 8th and 17th. Majority of spring corn appeared above ground between the 3rd and 10th.

May.—This month has been mainly dry, most of the rainfall occurring in three days. 2·07 in. rain were recorded, the normal for South-East England being 1·77 in. One ground frost was recorded. Sunshine hours, 6·33 per day; normal South-East England, 6·90. Mangels were drilled between the 2nd and 17th.

June.—Very dry and fairly warm. ·80 in. rain were recorded, the normal for South-East England being 1·89 in. Sunshine hours per day, 7·23; normal for South-East England being 7·20. Seeds hay was harvested during the month, in good condition. All corn crops in ear. Potatoes backward owing to slow germination. Market garden crops transplanted 8th-30th.

July.—Colder than normal, and wet. Rain fell on twenty days. 2·79 in. rain were recorded; normal for South-East England, 2·17 in. Sunshine hours, 5·79 per day; normal for South-East England, 6·96.

August.—Excessively wet, some rain falling on each of the first twenty-four days. 3·06 in. rain were recorded; normal for South-East England, 2·32 in. Sunshine hours per day, 4·89; normal South-East England, 6·48. Started cutting Wild White Clover seed on 7th. Seed carried on 25th. Corn cut between 7th and 28th, harvesting conditions being exceptionally bad.

September.—Fine and dry. 1·75 in. rain were recorded; normal South-East England, 2·13 in. One ground frost was recorded. Sunshine hours per day, 4·86; normal South-East England, 5·43. Potato lifting began on 21st. The last of the corn was carried on the 30th.

(*b*) Dates of Drilling and Planting.

	1927-28.	1928-29.	1929-30.	1931-32.
Winter Oats ..	—	—	—	—
Spring Oats ..	Feb. 20.	Feb. 8-Mar. 12.	Feb. 27-Mar. 10.	Feb. 3-Mar. 30.
Wheat ..	Oct. 1-Nov. 11.	Nov. 1-23.	Oct. 4-22.	Nov. 2-13.
Barley ..	Feb. 22-Mar. 1.	Mar. 11-Apr. 15.	Feb. 25-Mar. 6.	Feb. 5-Mar. 11.
Potatoes ..	Apr. 3-May 7.	Mar. 23-Apr. 9.	Apr. 12-24.	Apr. 12-24.
Mangels ..	May 7.	April 22.	May 1.	May 2-17.
Kale ..	July 2.	June 12.	—	—
Sugar Beet ..	May 9.	May 3.	May 8.	May 17.
Spring Wheat ..	—	—	—	Feb. 1.

(*c*) Dates of Harvesting.

	1928.	1929.	1930.	1931.
Seeds Hay ..	June 24-July 3.	—	June 7-19.	June 5-16.
Corn ..	Aug. 3-Sept. 3.	Aug. 7-30.	July 31-Aug. 27.	Aug. 7-28.

(*d*) Crop Yields per Acre.

	1928.	1929.	1930.	1931.	*Average 10 years England and Wales.*
Wheat (bushels) ..	54½	53	32	22½	31
Winter Oats (bushels) Spring Oats (bushels)	97	76	66	57½	38½
Barley (bushels) ..	62½	58	38	32	30½
Mangels (tons) ..	17	33	37	28	19
Swedes (tons) ..	14	13	—	—	12½
Potatoes (tons) ..	6½	6¾	6½	6	6
Sugar Beet (tons) ..	13¼	11¼	13	14¾	—

College Farms.

Cropping and Pastures.

Arable.	1929-30.	1930-31.	1931-32.	Grass.
Cold Harbour.			1. Potatoes	Barn Field
Field A	Mowing seeds	Grazing seeds	2. Grazing seeds	Upper Walloways
Field B	Barley	Mowing seeds	Grazing seeds	
Field C	1. Wheat 2. Barley	1. Potatoes 2. Barley	1. Oats 2. Seeds	
Field D	1. Market Garden crops 2. Potatoes	Barley	Barley	
Walloways	Barley	Barley	Barley	
The Park	1. Winter Oats 2. Spring Oats	1. Mangels 2. Market Garden crops	1. Wheat 2. Oats	
Silks.				Old Orchard
Field 1 (King's Field)	Barley	Barley	Mowing seeds	Goldup Meadow
Field 2 (King's Field)	Barley	Red Clover	Barley	Cooks
Field 3 (King's Field)	Red Clover	Barley	Barley	Forstal
Field 4	Mangels	Spring Oats	Spring Wheat	Crabbs & Tilbees
Field 5	Spring Oats	Spring Oats	Grazing seeds	Brook Field
Field 6	Grazing seeds	Grazing seeds	Grazing seeds	Pilrags
Amage.				
Long Field	Barley	Grazing seeds	Grazing seeds	Gore
Middle Field	Red Clover	Wheat	Mangels	Sparks
Bushy Field	Wheat	Wheat	Wheat	John Acre
Westons	Wheat	Barley	Barley	Longbrook
Little Crabbs	Market Garden crops	Market Garden crops	Spring Oats	Oaks

FIELD TRIALS AND EXPERIMENTS, 1932.

1. Barley Manuring (carried out at the request of Sir John Russell, F.R.S.).

Plots designed in the form of a 4×4 Latin Square, giving sixteen plots each of $\frac{1}{50}$th acre. Each of the $\frac{1}{50}$th acre plots was subdivided into four plots of $\frac{1}{200}$th acre. A total of sixty-four plots in a complex Latin Square.

Series A. To test the effect of nitrogenous manures.

Plot 1. *148 lb. nitrate of soda per acre.
,, 2. *112 lb. sulphate of ammonia per acre.
,, 3. *256 lb. ammonium humate per acre.
,, 4. No nitrogen.

* ·2 cwt. of nitrogen per acre.

Series B. To test the effect of superphosphate.

Plot 1. †242 lb. superphosphate per acre.
,, 2. No superphosphate.

† ·4 cwt. of phosphoric acid per acre.

Series C. To test the effect of sulphate of potash.

Plot 1. ‡139 lb. sulphate of potash.

„ 2. No sulphate of potash.

‡ ·6 cwt. of potash per acre.

During growth the plots receiving nitrate of soda and sulphate of ammonia were greenest and looked the best. The plots receiving ammonium humate were not perceptibly better than the control plots, which were poor and thin compared with the plots receiving nitrogen. The harvesting was carried out by sampling, four samples being cut and collected on each $\frac{1}{200}$th acre plot. These samples have been forwarded to Rothamsted Experimental Station for the nitrogen content to be determined. This was the second year of the trial.

2. <u>Potato Varieties.</u>

Plots $\frac{1}{40}$th acre, laid out in a Latin Square, with four replications of each variety, sixteen plots in all.

Plot 1. Arran Consul.

„ 2. Arran Banner.

„ 3. Seedling 675.

„ 4. King Edward.

This year the seed planted was once grown. The growth was good but about a fortnight later than in a normal season. This was the third year of the trial.

3. <u>Sugar Beet Manuring</u> (at the request of Sir John Russell, F.R.S.).

Plots designed in the form of a 5 × 5 Latin Square, giving twenty-five plots each of $\frac{1}{50}$th acre. Each of the plots was subdivided into four plots of $\frac{1}{200}$th acre. A total of one hundred plots in a complex Latin Square.

Series A. To test the effect of nitrogenous manuring.

Plot 1. *272 lb. nitrate of soda per acre.

„ 2. †78 lb. sulphate of ammonia per acre.

„ 3. *234 lb. sulphate of ammonia per acre.

„ 4. *†559 lb. ammonium humate per acre.

„ 5. No nitrogen.

* ·4 cwt. of nitrogen per acre.

† ·148 cwt. ammonia nitrogen per acre.

Series B. To test the effect of superphosphate.

Plot 1. *300 lb. superphosphate per acre.

„ 2. No superphosphate.

* ·5 cwt. phosphoric acid per acre.

Series C. To test the effect of muriate of potash.

Plot 1. ‡162 lb. muriate of potash per acre.

„ 2. No muriate of potash.

‡ ·75 cwt. potash per acre.

During growth the plots receiving nitrate of soda and the full dressing of sulphate of ammonia were greener and more conspicuous than the rest. The plots receiving the small dressing of sulphate of ammonia were also superior to the control plots. The plots

receiving ammonium humate were not perceptibly better than the control plots. All the plots received a basal dressing of 12 tons farmyard manure per acre.

First year of the humate, superphosphate and potash trials. Third year of the nitrate of soda and sulphate of ammonia trials.

4. Mangel Manuring.

To test the effect of various forms of nitrogenous manure. Twenty-five plots in a 5×5 Latin Square.

Basal dressing.

12 tons farmyard manure per acre.
4 cwt. superphosphate per acre.
2 cwt. muriate of potash per acre.

Nitrogenous manuring.

Plot 1. *216 lb. sulphate of ammonia per acre.
,, 2. †72 lb. sulphate of ammonia per acre.
,, 3. *559 lb. ammonium humate per acre.
,, 4. *1,056 lb. humic acid per acre.
,, 5. No nitrogen.

* ·4 cwt. nitrogen per acre.
† ·148 cwt. ammonia nitrogen per acre.

During growth the plots receiving sulphate of ammonia were very conspicuous. The plots receiving ammonium humate were slightly better than the control plots. The plots dressed with humic acid were not perceptibly better than the control plots until August, when they seemed to improve considerably. This was the first year of the trial.

5. Trial to Test the Effect of Removing all but the Strongest Shoot from the Potato Plants.

Varieties under Trial.

1. Majestic.
2. King Edward.
3. Great Scot.

Ten lengths of 9 feet were selected at random in each of the above varieties. Each 9 foot length contained seven plants. These plants were singled, the main shoot in each case being left and the remainder cut off just below ground level. The adjoining rows were used as a control, seven plants being selected and left untouched.

The plants were examined again in mid-July and any shoots which had since grown were removed. There was no marked difference in the height of haulm, flowering, date or disease infection between the control and the singled plants.

This was the first year of the trial.

6. TRIAL TO TEST THE EFFECT OF VARIOUS SEED DRESSINGS ON THE INFESTATION WITH LEAF NET BLOTCH (*Helminthosporium teres*) OF BARLEY.

Materials used :

1. Ceresan.
2. Mercuric Chloride Dust.
3. Agrosan A.
4. Agrosan B.

Barley seed (Plumage Archer) was selected from an infected crop. This was dressed with the above materials, all of which were in powder form. Sufficient infected seed was set aside as a control.

The seed was drilled, two drill widths of 78 feet length constituting a plot. The plots were laid out in the strip method with four replications of each treatment. During the first two months the untreated plots were much more affected with leaf net blotch than any of the treated plots, but later in the season all plants were affected.

This was the first year of the trial.

7. SPRING WHEAT VARIETIES.

Varieties under trial :

1. April Bearded.
2. Red Marvel.
3. Yeoman (Spring sown).
4. Little Joss (Spring sown).

The seed of the above varieties was drilled on February 1st. The plots were laid out in strips with four replications of each variety. Two drill widths of 78 feet length constituting a plot.

This was the first year of the trial.

THE STATISTICAL INVESTIGATIONS OF EXPERIMENTAL RESULTS.

Mr. H. B. Bescoby has made a special study of this subject during the past two years. For eight weeks in September, 1931 and April, 1932, he attended the Rothamsted Research Station to acquire the latest methods now being employed. The trials carried out by the Agricultural Department in the years 1931 and 1932 have been designed and the results calculated in accordance with these methods. Advice and assistance has been given to at least nine departments of the College in designing experiments and interpreting their results.

An extensive investigation of the experimental data for 1930, from the National Poultry Institute at Wye, has been in progress during 1932. This work has been carried out in co-operation with the Statistician of the National Poultry Institute at the Harper Adams Station.

Lectures on experimental technique have been given to students attending the diploma and degree courses and students have been encouraged to design trials and calculate the results obtained.

Two papers have been published on the practical application of statistical methods to field trials and it is interesting to note that they are being recommended by University authorities for the use of students taking courses in experimental technique.

SHEEP.

The Effect of Protein-Rich Meal on Wool Production.

Mr. N. L. Tinley has continued his work on wool production and in June, 1931, a trial was begun with eighty Border Leicester × Cheviot (half-bred) ewes to ascertain the effect of a protein-rich substitute on wool production.

The fleece weight produced by each ewe during the season 1930-31 was recorded at shearing time. The ewes were then divided into two groups so that the weight of wool produced by the two groups during the past year was equal.

The normal ration of concentrates was supplemented by 12 per cent of blood meal (82 per cent protein) in the case of one of the groups. During the experiment each ewe consumed 5 lb. of blood meal, costing 1s. per head.

All lambs were weighed at birth with the following results:

57 lambs in blood meal fed flock of average birth weight	10·72 lb.
60 lambs in control flock of average birth weight	9·94 lb.
Increased weight	·78 lb.

The number of lambs born per ewe in the two flocks was practically the same and all the above lambs were sired by the same ram.

The fleeces were weighed again in June, 1932. The fleeces of both flocks were lighter than in 1931, this probably being due to the abnormally high fall of lambs. The fleece weights for the two seasons were as follows :—

	1931.	1932.	Difference.
Control flock ..	7 lb. 10 oz.	6 lb. 5 oz.	1 lb. 5 oz. (loss)
Blood meal fed flock	7 lb. 8 oz.	7 lb. 3 oz.	5 oz. (loss)
	Increased weight 1 lb. per ewe.		

In addition to this the fleeces from the control group, when tested for medullated fibre, were found to contain more of these fibres than the blood meal fed group.

Testing Wool for Medullated Fibre.

New Zealand Romney Marsh wool has been severely criticized by manufacturers for the amount of medullated fibre it contains. In order to find whether Kentish grown Romney Marsh wool also contained medullated fibre, six pedigree flocks in Kent were tested during the spring of 1932.

Ten ram tegs were tested from each flock, ten staples being removed from each sheep and tested under benzol. These tests exhibited very great variations in the six flocks, some showing a high proportion of strongly medullated fibre, whilst others were almost entirely free.

In view of the fact that the production of medullated fibre appears to be a hereditary characteristic, it is hoped that in the near future a more systematic testing of Kent flocks will be possible, so that British breeders may keep pace with the New Zealand breeders, over 150 of whom are already carrying out the test in their wool sheds, with a view to eliminating or at least controlling the production of medullated fibre.

SOUTHDOWN SHEEP SURVEY.

A survey of the Southdown breed has been carried out during the past year. Information was received from sixty British flocks, eight New Zealand flocks, as well as a summary of the Southdown management in the U.S.A. It is hoped to publish an article on the breed and its management in the near future. Reprints of an article published during the year on the Kent or Romney Marsh sheep have been sent to Russia and South Africa by the Secretary of the Kent or Romney Marsh Sheepbreeders' Association.

THE EFFECT OF SHEARING LAMBS.

The Kent ewe lambs on the College farm were divided into two groups and one group was shorn in June, 1932. The future fleece weights will be recorded to indicate whether the wool production has been affected. The development of the sheep will also be observed.

PIG HUSBANDRY RESEARCH.

1. This work has been continued by Mr. Fishwick. The year 1931-2 was one of exceptional difficulty owing to the low price of pigs. Every possible economy was effected. The most notable were in connection with the feeding. Sharps were the cheapest of the cereal foods throughout the year, by utilizing the information obtained in the experiments carried out at this centre (9 and para. 8) it was possible to use this food to the maximum economical extent. A further economy was effected by using maize instead of barley meal as far as was consistent with efficiency, the former being much the cheaper. A saving of straw was effected during the late spring and summer by using no litter for stores and fattening pigs. No appreciable difference was noticeable except that the pigs did not keep themselves so clean as when their styes were well supplied with straw.

2. The possibility of substituting second grade fish meal for first grade is being examined as the second grade is usually the cheaper.

THE FEEDING AND MANAGEMENT OF BREEDING STOCK.

3. It was observed in 1929-31 that the growth of sucking pigs was influenced to a noticeable extent by the amount of supplementary food that they ate. An experiment was therefore carried out in the autumn of 1931 designed to ascertain whether the addition of a small quantity of dried separated milk to the supplementary ration would be beneficial. No clearly marked difference was obtained in this experiment, the results indicating that the dominant factors influencing the growth of sucking pigs were (1) the breeding, (2) the milk supply of their dam.

4. An experiment was therefore carried out in 1932 designed to ascertain whether it was possible to influence the sow's milk supply by feeding. The results obtained from two rations which differed greatly in composition were compared. The experiment

was started in the spring and continued until the late summer. The following were the rations used:

	Ration 1.	Ration 2.
Barley Meal	10	20
Maize Meal	20	20
Sharps	60	40
Fish Meal	7½	10
Soya Bean Meal ..	2½	—
Linseed Cake Meal ..	—	10
Containing digestible crude protein	15·2%	16·5%

The young pigs received the same ration as their dams from the time they started to eat. Those reared on Ration 1 did slightly better than those on Ration 2, the difference being apparently due to the fact that the young pigs ate more of the former ration than the latter.

5. An analysis of the results obtained during the past three years indicates that the growth of young pigs can be influenced to a marked degree by the feeding of their dams. The secret of success in rearing young pigs appears to lie in liberal feeding during the first month of the nursing period. The practice, which is frequently followed, of keeping the sow on a small ration in order to avoid scour appears to be fundamentally wrong. The best results, during the period under discussion, were obtained from sows which received all they would clear up readily twice a day from the third day after farrowing to the fourteenth day, when they were eating 14-16 lb. per day of a mixture containing 15·2 per cent of digestible crude protein.

A summary of this work was given in a paper read before the Agricultural Education Association in July (10).

6. Scour is a constant source of trouble amongst young pigs confined to styes. Young pigs which can run out on grass land do not as a rule suffer badly from this disorder. If sows and their litters housed in styes are allowed to run out, the ground in the immediate vicinity of the styes is liable to become heavily infected with the eggs of parasitic worms and eventually unsuitable for the young pigs. This difficulty may be overcome by making creeps in front of the styes through which the young pigs alone can pass on to the land in the immediate vicinity, while the dams are kept confined. Stock other than pigs can, of course, run over the same area. This system of management was tried during the late summer and appears to be very satisfactory.

7. The condition of a young pig is as important as its weight. There is no method of measuring condition but it is a factor which must of necessity be taken into account in experiments with young pigs. A method of grading has been evolved which enables a reliable comparison to be made between the condition of two young pigs.

FEEDING EXPERIMENTS.

8. The series designed to ascertain the maximum economical proportion of sharps in the ration of growing and fattening pigs was continued with pigs confined to styes. In these trials sharps was used in conjunction with maize meal, barley meal, soya bean meal and fish meal up to 70 lb. live weight and with maize meal, barley meal and soya bean meal plus minerals from 70-140 lb. live weight. The animals were sent to the butcher at about 140 lb. live weight. The ration containing 60 per cent

of sharps gave the most economical result in the first period. It was found that the pigs could be fattened on the ration containing 60 per cent of sharps, but that in the second period the pigs on this ration ate less and as a result grew slower than those on the rations containing a smaller proportion of sharps. The results indicate that 45 per cent is the most economical proportion during the second period. A preliminary paper on this subject was published (9).

9. A trial is in progress designed to ascertain the economy of "a store period" for pigs running on grass during the summer months.

PUBLICATIONS.

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(2) *Idem.* July 12th, 1932. The Technique of a Barley Manuring Trial. *Jour. S.E. Agric. Coll.*, No. 30, pp. 215-230.

(3) *Idem.* July 12th, 1932. Potato Manurial Trials. Main Crop. *Jour. S.E. Agric. Coll.*, No. 30, pp. 231-237.

(4) *Idem.* March, 1932. Manuring of Main Crop Potatoes. *Kent Farmers' Journal*, Vol. 31, No. 3, pp. 119-120.

(5) FISHWICK, V. C. Oct. 12th, 1931. Middlings in Pig Mixtures. *Farmer and Stockbreeder.*

(6) *Idem.* Nov., 1931. Wheat Meal *v.* Millers' Offals. *Jour. Min. of Agric.*

(7) *Idem.* Dec., 1931. Rearing Sucking Pigs—The Value of a Grass Run. *Jour. Min. of Agric.*

(8) *Idem.* Dec., 1931. Experiments, 1930-31. *Pig Breeders' Annual*, Vol. 10.

(9) *Idem.* March, 1932. Some Cheap Pig Rations. *Farmer and Stockbreeder.*

(10) *Idem.* Rearing Sucking Pigs. *Agric. Progress* (in the press).

(11) TINLEY, N. L. July, 1932. The Kent or Romney Marsh Sheep. *Jour. S.E. Agric. Coll.*, No. 30, pp. 186-193.

DEPARTMENT OF BOTANY

By S. T. Parkinson, R. T. Pearl and R. M. Harrison.

In addition to the usual routine and advisory work, observational and research work, as set out below, has been carried out by this department.

Cereals.

The statistical investigations, by Mr. R. M. Harrison, into the sowing of wheat at various depths, densities and row spacings were summarized in a report published in the *Journal of the South-Eastern Agricultural College*, No. 30, July, 1932.

Mr. F. H. Foster has examined, statistically, certain of the observations which he made on the effect of top-dressing fifty-four plots of Yeoman wheat with sulphate of ammonia at different times of the year, viz. January, March and May.

Statistical analysis showed that the date of the dressings had no significant effect on the straw plus grain yields of the plots. At the same time it was shown that an increase in the amount of the seed sown per plot, caused an increase in yield per plot, but the variation in row spacings had no significant effect on the total yields per plot. Mr. Foster has not yet found time to analyse the effect as far as yield of grain is concerned apart from straw.

Messrs. J. M. Trew and S. J. Jordan continued the precision records on two types of wheat in connection with the Agricultural Meteorological Scheme. The plots were harvested under ideal conditions and samples and data were sent to Rothamsted according to instruction.

Grassland.

Mr. R. M. Harrison has completed the botanical analysis of the herbage on the thirty permanent pasture plots in Brook Field. These analyses have been carried out for some years and the plots are now reverting to the normal condition of the surrounding grass in the field.

Mr. Harrison has also commenced botanical analyses of certain Romney Marsh pastures. These are in connection with the types of soil series as established by Mr. L. W. Cole and Dr. J. K. Dubey.

Pyrethrum.

Acting in co-operation with Mr. S. G. Jary, the department is starting an investigation into the botanical characters of Pyrethrum and into the possibility of improving different strains of Pyrethrum plants. Seedlings supplied by Mr. Jary have been planted out under varying conditions, and type plants have been selected, described and planted out. Mr. E. K. Eames has undertaken to assist in carrying on the experiments. Mr. R. M. Harrison has made notes on the characters of selected plants and propagations have been made vegetatively and by seed.

PHENOLOGICAL GARDEN.

Observations have been continued throughout the year and a report has been forwarded to the Ministry of Agriculture.

FOODSTUFFS.

Messrs. E. C. Bolton and F. R. Peters started an investigation into the microscopical character of seeds of the Polygonaceae but, unfortunately, were unable to complete it before leaving. Mr. M. N. Lucie-Smith is investigating the character of some tropical beans.

POMOLOGY.

(i) Mr. R. T. Pearl is continuing his work on the morphological characteristics of apple varieties. The intention is to provide more complete descriptions of varietal character than are at present available. Observations are being made on the characters of the inflorescence , summer and winter wood shoots ; and the internal and external structure of the fruit. A preliminary paper has already been published on the character of the inflorescence.

During the current season observations have been initiated on the inflorescence of pear varieties. There is reason to think that this may prove as valuable a means for the identification of pears as it is in the case of apples. Preliminary observations on foliage characters are also being made, but, as regards winter characters of the wood, the range of varietal difference seems to be even more limited than in apples.

(ii) Mr. E. G. Ing has carried out preliminary observations on varietal characteristics of cherries at flowering time. In the present confused state of cherry nomenclature he makes no claim that the varieties examined were correctly named. His results are of some interest as indicating characters of possible value in diagnosis. They may be summarized briefly as follows : Observations were made on varieties in two locations in East Kent. In one case the trees were espaliers and in the other growing as standards in grass orchard. It must be emphasized that this is only one season's work and there has been no opportunity to take into account the possible influence on the inflorescence of such factors as climatic conditions, situation, cultivation, vigour and bearing age, and rootstock. Subject to these qualifications the following characters appeared to be of possible diagnostic importance : season of flowering ; the number of flowers per inflorescence (e.g. *Florence* appeared to be few-flowered) ; length and possibly colour of pedicels ; size of flower (e.g. *Géante de Hedelfingen* large-flowered, *Waterloo* rather small) ; pose and overlapping of petals ; form of the margin and apex of the petal. Considerable individual variation was encountered in the shape of the petal. Significant differences were not observed in the relative length of stamens and style (except in the apparently long-styled *Bigarreau de Schrecken*).

(iii) During the current season Mr. G. K. Argles made measurements, at ten-day intervals, on the growth of wood shoots of apple trees. For this purpose trees of certain rootstocks on their own roots, and also trees grafted with two scion varieties were used. Final analysis of the measurements has still to be made, but Mr. Argles states that in some cases the results may confirm one of Swarbrick's conclusions that the total amount of extension growth made by a tree is determined by the rate of retardation of growth during the latter part of a season, rather than by differences in time of growth initiation, or differences in rate of growth early in the season (vide *Jour. Pom. Hort. Sci.*, VII, 1928, pp. 100-129).

HORTICULTURAL EDUCATION ASSOCIATION.

In November, 1931, Mr. R. T. Pearl was appointed Honorary Editor of the publications of the Horticultural Education Association. Although this association has been in existence some twenty-seven years it has rarely issued publications of outstanding importance. The immediate objective, therefore, is to provide an annual publication, which shall include important articles and research papers on modern aspects of the science and practice of commercial horticulture. This publication, under the style of the *H.E.A. Year Book*, is to be issued shortly and ought to prove a valuable instrument for furthering horticultural education.

PUBLICATIONS.

HARRISON, R. M. July 12th, 1932. Investigations on the Sowing of Wheat. *Jour. S.E. Agric. Coll.*, No. 30, pp. 247-265.

PEARL, R. T. 1932. The Inflorescences of Apple Trees, Their Use in the Identification of Varieties. *Jour. Pom. Hort. Sci.*, X, No. 1, pp. 19-26.

PEARL, R. T. July 12th, 1932. Apple Rootstocks. Nos. I to XVI. A Review Summary of the Publications of East Malling Research Station. *Jour. S.E. Agric. Coll.*, No. 30, pp. 194-214.

ENGINEERING DEPARTMENT

By Cornelius Davies.

Conference and Show.

The writer attended a Power Farming Conference held at Rothamsted on February 9th, and acted as Machinery Judge at the Sussex County Agricultural Show, Eastbourne, on June 22nd, 1932.

Ministry of Agriculture Machinery Advisory Committee.

The writer has continued his service on this Committee. A report on Education in Agricultural Engineering was presented by the Committee to the Ministry of Agriculture.

Soil Cultivation Experiments.

The residual effects of last year's soil treatments (Simar, Pulverator, digger and general purpose ploughs and spade and fork hand-dug) were studied on the subsequent crop of seeds hay, which was cut on June 21st. There were no significant differences.

Consolidation Experiments.

It was reported in this *Journal* (July, 1932, No. 30, p. 57) that a heavier yield of barley (28·42 cwt. per acre) had been obtained on Wye Loam along tracks made by a tractor than between the wheel marks (16·42 cwt. per acre). It was not known whether consolidation of the soil, depth of sowing (although there was some evidence that this was a contributing cause), cultivating effect of the wheel strakes or other factors were responsible for the better yield. A series of experiments was therefore planned with the object of studying and controlling some of these factors. Two soil types, Wye Loam and Sharbrooks Silt Loam were chosen upon which to observe the effects of the following treatments :

1. Not specially consolidated.
2. All the surface consolidated before drilling.
3. All the surface consolidated after drilling.
4. Consolidated in strips before drilling, to simulate the effects of the tractor wheels.

The consolidation was done with a roller designed and made by the department. It had the same width and exerted a pressure per square inch similar to that of the tractor. As far as Wye Loam was concerned the soil conditions resembled those obtaining last year, when the tractor packed the soil. The plots were arranged in such a way that a 4×4 Latin Square, or Randomized Blocks, with six replicates, was present on each field. Barley was sown.

SHARBROOKS. (Sharbrooks Silt Loam.)

Plots 1/80 acre, drilled February 8th.

Yields are in cwt. per acre.

	Not rolled.	Rolled before drilling.	Rolled after drilling.	Rolled in strips.
Grain	26·25	25·35	25·35	27·14
Total Produce ..	67·5	68·92	67·37	70·35

There are no significant differences, although there is evidence that the "strips" tended to produce a heavier crop. This treatment resembles the tractor rolling more than the others.

FIELD D. (Wye Loam.)

Plots 1/80 acre, drilled March 4th.

Yields are in cwt. per acre.

	Not rolled	Rolled before drilling.	Rolled after drilling	Rolled in strips.
Grain . ..	28·6	25·95	28·3	28·8
Total Produce ..	69	68·3	69·7	69·1

None of the differences is significant. Thus all the conditions prevailing last year (when the tractor tracks produced a larger yield) could not have been present.

METHODS OF SOWING.

Three methods of sowing cereals were tested. These were:

1. The usual farm drill, rows 7 in. apart.
2. Dunn's method.
3. "Pocket" sowing.

Several models of Dunn's drill have been tried in the past, but it has never been possible to obtain a wide scatter of seed, and proper covering has always been difficult. This year all the work was done by hand. Drills 8 in. wide were opened with a special tool, the bottom was well firmed by tramping, and the seed was covered by depositing soil on top in such a way that the seed was not displaced. The object of the "pocket" system is to facilitate inter-cultivation when necessary, and to decrease tillering while increasing the weight of grain per shoot. The "pockets" consist of circular depressions, 3 in. in diameter, 10 in. apart, each containing about twenty grains, which gave the same rate of seeding per acre as the farm and Dunn's drills. The plots were arranged in

the form of two 3 × 3 Latin Squares on Wye Loam and barley was sown on March 7th and 8th. The yields were as follows :

Plots 1/160 of an acre.

Cwt. per acre.

	Ordinary drill	Dunn's	Pockets.	Standard error	Significant difference.
Grain	32·6	31·2	27·1	1·09	3·45
Total Produce	81·4	75·82	66·9	—	—

The " pocket " sown treatment gave a significantly lower yield than the other two. There was no significant difference between Dunn's and the ordinary farm method.

During the early stages of growth the " pocket " plots were much stronger and greener. All these plots were somewhat laid, but none was worse than the others.

PLACEMENT OF FERTILIZERS.

A preliminary study was made of the effects of the placement of fertilizers relative to the seed. The work was mainly done by two senior students, Messrs. C. E. Roe and G. P. B. Shaw-Yates. There were four treatments :

1. Fertilizer sown on the surface after drilling.
2. Fertilizer sown with the seed.
3. Fertilizer sown below the seed.
4. Fertilizer sown to the side of the seed.

On account of the smallness of the plots the error of the experiment was large ; but there is sufficient evidence available to show that No. 1 is not necessarily the best.

DAVIES COMPACTOMETER.

Information is still being collected, with the aid of this instrument, on the question of the packing of the soil by various tractors, implements and animals which pass over it.

The penetrability of steel points of greater diameters than those previously experimented with is being studied in soils and organic matter. It has been necessary to construct a large box containing finely sifted soil to get a uniform medium for this work. A summary of a paper read by me at Liège dealing with this instrument is published in " Congrès International de Génie Rural," recently issued.

TRANSPLANTER.

This machine, with which we have been associated since the first experimental model was tried in 1928, was subjected to a thorough trial during November, 1931, and our findings were set out in a bulletin. We found that the planter is capable of planting at a rate of over eight thousand plants per hour (a very good hand dibbler averages about six hundred per hour). The machine was awarded a Silver Medal at the Royal Agricultural Show, 1932, and is now on the market.

SPRAYING MACHINES.

The work of some machines used to apply liquid insecticides and fungicides to trees has been measured and examined. There is sufficient evidence that greater precision and perhaps more efficient and economical working could be brought about by means of a critical engineering study of the whole problem of spraying. Some preliminary work has been done, and it is hoped to be able to develop this further.

ADVISORY WORK.

The department has throughout the year given advice to farmers and others on mechanical and electrical matters. An opportunity occurred on Mr. de Ledesma's farm, Popham Court, Hampshire, of measuring with precision the wear on three tractors, which were dis-assembled. The complete working history of these tractors is known, and the combined information is of great technical value.

PUBLICATIONS.

DAVIES, C., and SMYTH-HOMEWOOD, G. R. B. 1932. Report on Trials with a Transplanting Machine. [Wye: Departmental Bulletin.]

DAVIES, C. July 12th, 1932. The Cultivation Experiments of 1929-1931. *Jour. S.E. Agric. Coll.*, No. 30, pp. 97-101.

Idem. July 12th, 1932. A Test of a New Type of Force-feed Cereal Drill. *Jour. S.E. Agric. Coll.*, No. 30, pp. 102-109.

Idem. July 12th, 1932. A Note on Mole Draining. *Jour. S.E. Agric. Coll.*, No. 30, pp. 110.

Idem. August 8th, 1932. "Tractor and Horse, Packing of the Soil." Letter to *The Times*.

DEPARTMENT OF ZOOLOGY AND GEOLOGY

By S. GRAHAM BRADE-BIRKS and BASIL S. FURNEAUX.

I. MYRIAPODA.

Dr. Brade-Birks is joint author of a paper on the occurrence of *Lithobius borealis* in England which is now in the press. Some attention has been paid to the literature of the Myriapoda in the library of the Zoological Society of London. In accordance with a suggestion of Prof. F. Silvestri, Dr. Brade-Birks dissected another of the type specimens of *Cylindroiulus latistriatus* (Leach) preserved in the British Museum, but detailed study of the preparations has not yet been made. Studies of some Archipolypoda from Scotland are in progress and a paper on the type specimen of *Euphoberia ferox* should shortly be ready for the press. Examination of a number of British millipedes and centipedes has been made for correspondents during the year.

Mr. Rolfe has been making a study of a number of Diplopods occurring in the neighbourhood of Wye and has paid especial attention to *Polydesmus angustus* Latzel.

II. SOIL STUDIES.

Satisfactory progress has been made during the year under review and several papers have been published. Two post-graduate students, Messrs. L. W. Cole and J. K. Dubey, under the supervision of Dr. Brade-Birks, carried out researches independently upon the soils of Romney Marsh and both were successful when they presented theses embodying their results for higher degrees as internal students of the University of London. Mr. Cole obtained the degree of M.Sc. and Mr. Dubey that of Ph.D. Mr. Cole and Dr. Dubey also prepared a joint paper embodying important results and this was published in July, 1932. Mr. Cole and Dr. Dubey have added very considerably to our knowledge of the soils of Romney Marsh and it is clear that there is a close correspondence between soil profile and pasture performance.

During the year Mr. Furneaux has been engaged in researches under the Fruit Soils Survey Scheme, which is fully reported by Dr. Goodwin in his account of the work of the Department of Chemistry.

Mr. J. Low, M.Sc., has continued his researches on the soils of Somersetshire and of the Wirral and has made satisfactory progress.

Mr. R. M. Harrison, B.Sc., of the Department of Botany, has been working upon the flora of Romney Marsh pastures in conjunction with pedologists in our department. His results are not yet available, but promise to be very interesting.

Dr. Brade-Birks and Dr. Dubey have collaborated on the subject of " Soil Monoliths " and intend to publish a joint paper on the subject soon.

Mr. E. R. Bransby published a paper on some local minerals and Mr. H. H. Glasscock in continuation of his studies on soil minerals, published a paper on those of the Wye series.

The Romney Marsh Soil Committee has continued to meet under the chairmanship of the Head of the Department and has been able to correlate the pedological studies being carried out in the area. Mr. S. J. Travers, Assistant Agricultural Organizer for East Kent, has been co-opted to the Committee, which in addition to the Chairman, also includes Mr. B. S. Furneaux, M.Sc., Mr. L. W. Cole, M.Sc., Dr. J. K. Dubey, Mr. I. B. Prowse, B.Sc., and Mr. R. M. Harrison, B.Sc.

Dr. Brade-Birks lectured at Godmersham on January 1st, 1932, to the local Gardeners' Association, and at St. Augustine's College, Canterbury, on February 20th, on " The Nature of the Soil."

Dr. Dubey prepared and exhibited a fine series of monoliths of Romney Marsh soils which created much interest at the Kent County Agricultural Show at Maidstone.

Dr. Brade-Birks attended the course of lectures on the Biological Control of Pests given by Professor F. Silvestri in London in May, and Professor Silvestri paid a brief visit to Wye on May 30th.

Mr. B. S. Furneaux gave a lecture on January 20th, 1932, to the East Kent Natural History Society on " Soil Survey Work in Kent," and on " The Soils of Kent " to the Ashford Geographic Society on March 2nd, 1932 ; he also lectured at Molash on February 2nd, 1932, on " Flint Implements " and at Broadstairs on " The Geology of Kent " on January 31st, and organized and conducted a tour of the Weald for the Birkbeck Geographic Society on June 4th, 1932.

Professor Linwood L. Lee's important memoir upon soil classification, which appeared in this *Journal* in July, 1932, was published during the year as a departmental bulletin with an editorial note by the Head of the Department.

The Head of the Department again acted as Editor of the College *Journal* in January and July, 1932.

PUBLICATIONS.

BRADE-BIRKS, S. G. July 12th, 1932. The Place of English Soils in the International Classification. *Jour. S.E. Agric. Coll.*, No. 30, pp. 166-169.

BRANSBY, E. R. July 12th, 1932. Some Minerals of the Lower Greensand Beds of the Ashford District, Kent. *Jour. S.E. Agric. Coll.*, No. 30, pp. 111-117.

COLE, L. W., and DUBEY, J. K. July 12th, 1932. Soil Profile in relation to Pasture Performance in Romney Marsh. *Jour. S.E. Agric. Coll.*, No. 30, pp. 141-169.

FURNEAUX, B. S. (See Department of Advisory Chemistry.)

GLASSCOCK, H. H. July 12th, 1932. Soil Minerals of the Wye Series. *Jour. S.E. Agric. Coll.*, No. 30, pp. 118-122.

LOW, A. J. April 30th, 1932. Climate and Parent Material in Soil Formation in South-West England. *Nature*, 129, 655.

LOW, A. J. July 12th, 1932. Soil Profiles Developed in Central Somerset. *Jour. S.E. Agric. Coll.*, No. 30, pp. 239-243.

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South-Eastern Agricultural College

WYE

With the Editor's Compliments

EDITORIAL

It is a pleasure to record the gift to the College by Major R. J. K. Mott of Wall House, Bagborough, Taunton of two interesting manuscripts. The former $8\frac{3}{8}$ inches by $10\frac{3}{8}$ inches by $\frac{1}{8}$ inch in a marbled paper binding has an 18th century paper label "A Survey and Rental of Wye College." The MS. is written in a clear 18th century hand on one side of the paper only, and consists of fourteen written pages, eight pages being devoted to :—

> The late Colledge of Wye in the Countie of Kent.
> The Perticuler Survey taken the twenty-third day of the moneth of October in the first year of the reigne of our sovereigne Ladie Queen Marie, of all the Mannors; Lands, Tenements, Personages, and Vicarages, late apperteining to the same Colledge, in the said Countie, now in the hands, and Possession of S[r] Mauris Denys, Knight, as herafter shall appeare

Pages 9-14 inclusive, give :—

> Rentale Collegii de Wye factum primo Anno Magistri Edwardi Bowdon, 36° An° Regni Regis Henrici Octavi, menso Octobris Anno Dom[i]. 1544°.

and at the end is pasted in an engraving entitled " Sigill[m] Coll : de Wye."

The other MS. presented by Major R. J. K. Mott is $7\frac{1}{2}$ inches by $9\frac{1}{8}$ inches by $\frac{1}{8}$ inch and has a vellum cover the inside of which reveals part of a deed with mention upon it of Sir William Pynsent, Thomas Kemp, Henry ffrancklyn, Mary Spratt, . . . [name cut] Austen and his wife, Elizabeth Spra . . . Elizabeth She . . . and properties in Ashford Wille . . . and Mersham, Kent.

On the first page of the cover is inscribed :—

> Abstracts of Title Deeds Relateing to Wye Colledge given by Sir George Wheler as an Augmentation to Lady Joanna Thornhills Charity for the Education of the poorest sort of Children of Wye Town and of the Title Deeds of a Farme called Amyings in Wye and Brooke and of the Title Deeds of Forty Acres of Land in Aldington and Hurst purchased by the said Lady Joanna Thornhills E(x)ecutors for the said Charity. [Also an Abstract of the Title Deeds of 34 Acres of Land in Seavington purchased with £600 given by the Lady Joanna Thornhills Will for several Charitys.]
>
> For John Sawbridge Esquire

All this is written in an 18th century hand, the parts in brackets having been added at a later date than the rest.

The book contains sixty-four pages of which forty-four are written, twenty being blank.

The Rev. Dr. C. W. H. Amos has also recently made an interesting gift of newspapers and manuscripts relating to the history of the College. Of this gift the principal item is a book $8\frac{1}{8}$ inches by 14 inches by $1\frac{1}{2}$ inches, entitled

> The Wye College & Grammar School.
> The Wye Charity Schools under Lady Thornhill's Will.
>
> The Charity Comissioners Schemes from 1877 to 1893 and Testators Wills.
>
> The Establishment of The South Eastern Agricultural College on the old site in 1893 and its Scheme.
>
> The Governors' Accounts from 1877 to 1893 with copy Wills and particulars.
> 1877-1893.

and impressed on the back is the following :—

KENT
WYE COLLEGE SCHOOLS
Lady Thornhill's Charity School. Sir G. Wheler's Gift.
Copy Wills &c. Governors Accounts for 16 years
From 1877 to 1893

Written within the cover are the following particulars :—

This Book was compiled by the late Mr. George Pembrook Amos, who assumed the name of George Pembroke Amos-Pembroke, Solicitor, Eldest son of the late Mr. George Amos, Solicitor, of Wye, Kent. Upon the death of Mr. G. P. Amos-Pembroke on 17th March 1912, the Book became the property of his Brother Mr. Gilbert Pembrook Amos of Ford, Herne, Kent. Upon whose death on 30th. September 1928 it passed into the possession of his nephew The Reverend Charles William Hale Amos, D.D., by whom it is presented to the South-Eastern Agricultural School and College, Wye, Kent.

W. H. EVANS
(Deputy-Administrator of the Estate of Gilbert Pembrook Amos dec[d].)
10th. March, 1933.

This book has 434 numbered pages and contains manuscript and printed matter dealing with the subjects mentioned on the title page.

I am indebted to the Principal and to the Librarian for facilities to describe these gifts and to the latter for help in preparing these remarks.

To Mr. H. Martin I am indebted for the useful index to the present issue of the *Journal*.

S. GRAHAM BRADE-BIRKS.

THE INFLORESCENCES OF APPLE TREES

II.—AN HISTORICAL REVIEW TOGETHER WITH FURTHER VARIETAL DESCRIPTIONS

By R. T. Pearl, B.Sc., A.R.C.S., D.I.C.

In a previous paper (Pearl, 1932) a descriptive account was given of the characters of the inflorescence which can be employed to differentiate between apple varieties. In the light of experience with about sixty varieties the relative value and constancy of the characters was discussed and their taxonomic value illustrated by detailed tabular descriptions of ten well-known apple varieties. It was further pointed out that no part of the tree offers a more reliable means of identification than the inflorescence, and from a utilitarian standpoint the floral characteristics afford an easy method of recognition, both in young and older trees at times when wood, foliage or even fruit characters are unavailable or difficult to employ with confidence. The present paper continues the project with an historical survey of the limited literature of the subject, followed by some additional varietal descriptions of better known apples.

Historical.

Comparatively few systematic pomologists have made any reference to floral characters in their descriptions of apple varieties. Duhamel du Monceau (1768) seems to have been the earliest writer to make definite use of them. He briefly describes the flowers of twenty-two out of the thirty-nine varieties included in his work. Most of the descriptions give particulars of the size of the flowers, length and breadth of the petals, their colour above and below and the pose of the corolla ; other particulars are added from time to time such as : the shape, size and colouring of the sepals, the shape, surface folding or crinkling and claw characters of the petals, the stoutness and pubescence of the staminal filaments, the relative length of styles and stamens. The amount of detail is remarkable for the period during which he lived and later writers have not added very much to his descriptions. In the series of enlarged editions of his *Traité des Arbres Fruitiers* which culminated in that of Poiteau and Turpin (1807-1835), a somewhat larger number of apple varieties are described and floral descriptions similar to those of the earlier work are usually included. A number of additional characters not mentioned by du Monceau are introduced here and there such as : the number of flowers per inflorescence, absence of scent, the length, stoutness and pubescence of the pedicels, presence of bracteoles, the pubescence and pose of the sepals, the pose of the stamens, the colour of the anthers, the thickness and pubescence of the styles, length and pubescence of the style column. The flower or inflorescence is illustrated in colour and occasionally a flower is shown in longitudinal section : since the drawings are mostly of flowers before anther dehiscence, they probably fail in some instances to show the full length of the styles and the ultimate pose of the corolla and stamens. In his *Pomologie Française* Poiteau (1838-46) describes and figures the flowers of some of the fifty-seven varieties included, but his descriptions lack some of the thoroughness evinced by his earlier contribution. The only other pomologies of any magnitude in which floral

Vertical section of a flower with complete pedicel ($\times \frac{1}{2}$ diam).

1. Allington Pippin 2 American Mother 3 Annie Elisabeth.
4 Beauty of Bath 5 Bismarck

descriptions appear are the works of Mas (1865-72, 1872-84). His varietal descriptions are a great advance on previous attempts, both in the complete uniformity of arrangement and in the precision of his language. Several hundred apple varieties are described and in each case there is included a brief description of the floral characters : size of flower ; shape and pose of petal, colour outside and inside, stoutness and pubescence of pedicels. It will be noticed that Mas makes no use of the reproductive organs of the flowers in his descriptions. More recently Lauche (1882-3) has provided coloured illustrations of the flower bud, full open flower and of an isolated petal of most of the hundred apple varieties included in his work, but there are no written descriptions of floral characters. The flower drawings are good, but in the colouring there is hardly sufficient distinction between the varieties. Hatton (1919) in the work at East Malling on Paradise apple stocks gives brief floral descriptions of eight clonal varieties of rootstock, thus helping to fill another small gap in the systematic records. The short list of varietal descriptions included in the author's paper (Pearl, 1932) is an initial move towards augmenting the very meagre records of English varieties.

Characters Used in Varietal Descriptions of the Inflorescence.

Bunyard (1912) gives an account of characters utilized in the description of apple flowers and their relative value in varietal diagnosis. The present author (Pearl, 1932) has recently supplemented this information with fuller descriptions of the characters of the inflorescence as a whole and of certain features of the flower not previously considered. In the present paper a general description of the inflorescence will suffice.

The Inflorescence Described.

The inflorescence of the apple is produced from a mixed bud, namely one giving rise both to flowers and vegetative growth. The bud axis initially elongates to a short greenish pubescent stem, the so-called bourse, knob or cluster base, which bears a terminal corymbose cyme of four to nine pedicellate crimson to white flowers. Below the flowers foliage leaves are spirally arranged on the bourse usually in a close rosette. Immediately above the basal bud-scale scar-ring there may be one to three, often fugacious folioles. The central flower of the cluster is strictly terminal, it has the shortest and stoutest pedicel and opens first, often a day or more in advance of the lateral flowers. These latter are axillary, subtended either by the uppermost foliage leaves or more usually by small fugacious bracts ; their points of insertion are usually so close to the terminal flower that the inflorescence appears umbellate, but on a long or vigorous bourse the outermost flowers may be disposed in a corymbose manner distinctly below the apex. During flowering or soon after, vegetative buds develop in the axils of some of the upper foliage leaves on the bourse, giving rise to branches, which continue the characteristic lateral forking of the fruit-spur (see also Boyes, 1922 ; Vyvyan and Evans, 1932). Normally there are two such buds, but one, three or very rarely four lateral buds may develop in this manner.

The individual flower has been described by Duhamel du Monceau (1768, Vol. I, pp. 273-4) with such admirable clarity that it is of more than historical interest to reproduce his original description : " Les fleurs du Pommier sont en bouquet. Toutes les queues d'un bouquet sont attachées sur l'extrémité du pédicule du bouton d'où elles sont sorties, et non pas disposées le long de ce pédicule, comme celles du Poirier. Elles sont composées 1° d'un calyce charnu d'une seule pièce, de la forme d'un godet divisé par les bords en cinq échancrures longues, diminuant régulièrement de largeur depuis leur naissance jusqu'à leur extrémité qui se termine en pointe, ordinairement garnies de

Vertical section of a flower with complete pedicel (× ¾ diam.).

6. Blenheim Orange
9. Ellison's Orange
7. Charles Ross.
8. Edward VII.
10. Gladstone.

duvet : 2° de cinq grands pétales disposés en rose, creusés en cuilleron, de grandeur, de forme et de proportions différentes, et panachés de rouge plus ou moins foncé suivant l'espèce : 3° d'une vingtaine d'étamines attachées aux parois intérieures du calyce, terminées par les sommets jaunes, figurés en olive, et divisés suivant leur longueur par une raînure : 4° d'un pistil formé de cinq styles assez longs, et d'un embryon qui sert de fond au calyce."* To this description it is only necessary to add that in the apple the styles are surmounted by small papillate stigmata and united at the base to form a style column of varying length. The free portions of the styles are occasionally furnished with scattered tomentum, but the column and especially the point of junction of the styles are more frequently and densely hairy. Tetramerous flowers are quite frequently formed and some irregularity in the number of stamens occurs commonly enough, but numerical irregularities in respect of other floral members are encountered comparatively rarely.

The Varieties Described.

Full and uniform tabular descriptions are provided in the case of fifteen varieties not dealt with in the earlier paper (Table I). Attention is again drawn to the limitations to the utilization of foliar characters mentioned therein (Pearl, 1932).

Glossary of Terms.

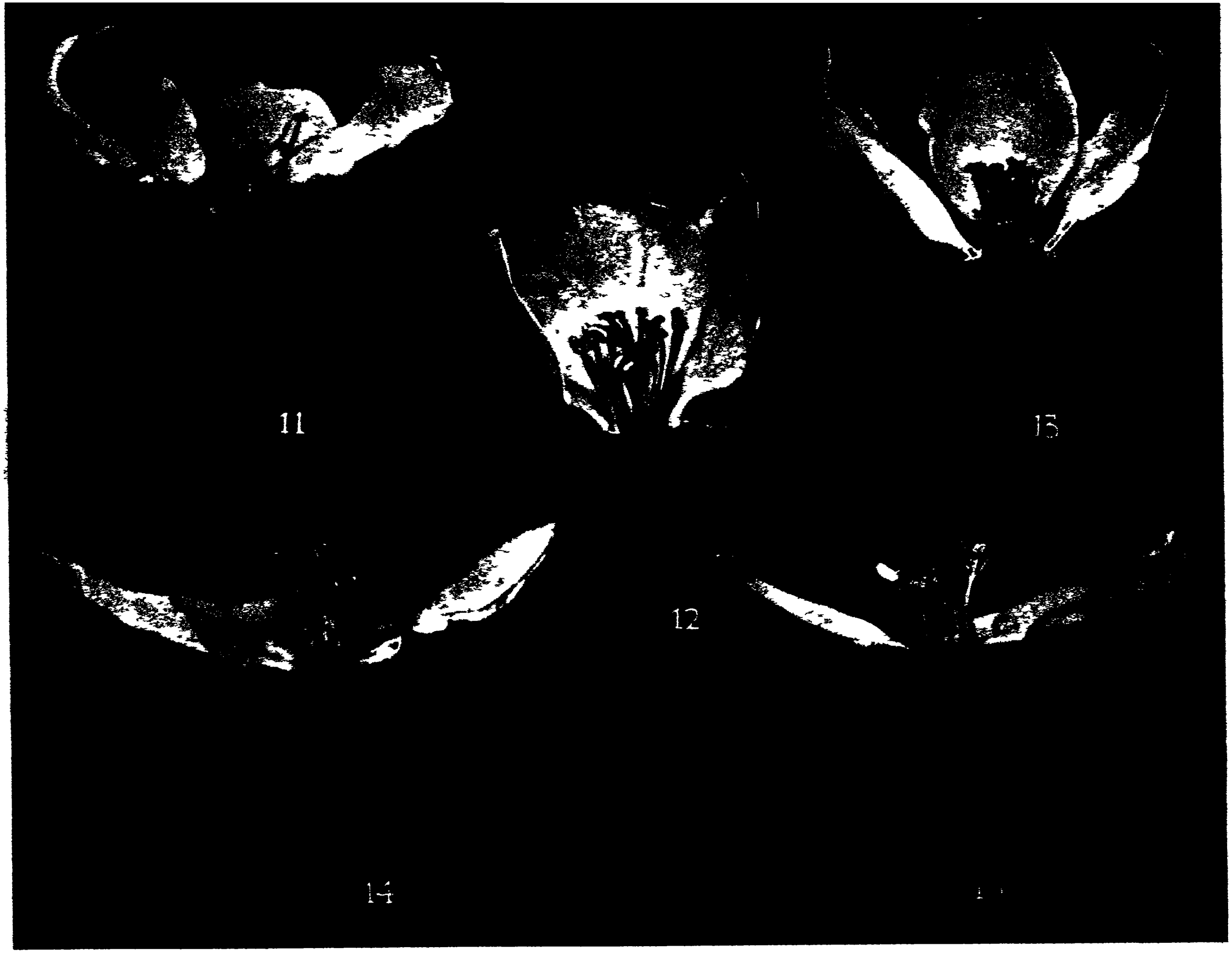
A descriptive glossary of the technical and semi-technical terms used in the varietal descriptions follows. Since the definitions refer specifically to the structures encountered in the apple inflorescence, the explanatory details are often inapplicable to other species of plants.

Acuminate—drawn out to a fine point (e.g. leaf tip, Allington Pippin).
acute—sharply pointed but not tapering or drawn out.
anther—the terminal bilobed portion of the stamen, usually yellowish, contains the pollen.
attenuate—narrowed.
attenuate-ovate—(of the petal) narrow, broadest near the base, tapering to the apex and claw.
axillary—growing in the angle formed by a leaf with the stem.

Bourse—the cluster-base, the short sometimes swollen stem bearing terminal flowers.
bract—a small modified leaf subtending a flower.
bracteole—a small bract on the pedicel.
bullate—blistered or puckered (like a Savoy cabbage leaf).

Calyx—the sepals collectively, the five outermost green teeth or lobes, which protect the unopened flower.
calyx-tube—the united base of the sepals just above the ovary, barely visible in the apple flower.

* This I translate as follows :—" The flowers of the apple tree are in clusters. Every flower stalk in the cluster is inserted at the extreme apex of the cluster base (*pédicule du bouton*) on which they are borne and are not disposed laterally on this peduncle as is the case with those of the pear tree. They are composed (1) of a thick united saucer shaped calyx, marginally divided into five long lobes (*échancrures*), each tapering regularly to a pointed apex and usually covered with down ; (2) of a whorl of five large petals, hollowed out like a spoon, differing in size, shape and proportions and suffused with a paler or deeper red according to the kind ; (3) of about twenty stamens inserted on the inner surface of the calyx tube, with yellow heads marked with olive green and divided by a groove throughout their length ; (4) of a pistil composed of five rather long styles and an ovary inserted below the calyx."



Vertical section of a flower with complete pedicel (× $\frac{3}{4}$ diam.).

11 Lady Sudeley 12. Laxton's Superb. 13. Norfolk Beauty.
14 Ribston Pippin 15 Stirling Castle

claw—the petal stalk, the narrowed base by which the petal is attached to the receptacle.

cluster-base—see *Bourse.*

coherent—holding together.

concave—having a hollow or cupped surface.

convex—having an arched or spherical surface.

cordate—heart-shaped, having a notch at the base on each side of the claw.

corolla—the petals collectively, the five free white or crimson display leaves of the flower.

coroniform—(of the stamens) corona-shape like the trumpet of a daffodil (e.g. the stamens collectively of Bramley's Seedling).

corymbose—like a corymb, arranged in a flat-topped flower cluster.

crenate—having blunt rounded teeth.

creno-serrate—having rounded serrate teeth.

cupped—(of a leaf or petal surface) hollowed like a spoon : (of the corolla) the petals collectively forming a cup shape.

Dehisce—to split or burst open : (of the anther which breaks open at maturity exposing the pollen).

dentate—having medium-sized sharp teeth pointing outwards.

Entire—with an even untoothed margin, smooth.

epigynous—having the sepals, petals and stamens apparently above the ovary, owing to the receptacle surrounding and being united with the ovary.

Filament—the slender stalk of the stamen.

foliole—a small leaf arrested in growth, found at the base of the bourse just above the bud-scale scar-ring.

fugacious—soon withering.

Glabrous—entirely without hair.

Hooded—having the apex of the petal strongly curved upwards and inwards (like the main " petal " of the Monkshood flower).

Inflorescence—a cluster of flowers borne terminally on a bourse.

Margin—the edge of a petal or leaf-blade.

Ob—a prefix signifying inversely, in the opposite manner.

oblong—much longer than broad, usually parallel sided and rounded at the ends.

obovate—rounded and broadest near the apex, tapering to the base.

obsolete—rudimentary, hardly visible.

obtuse—blunt ended.

orbicular—of rounded outline, circular.

orbicular-cordate—very broad, roundish, notched at the base.

oval—somewhat longer than broad, rounded at both ends.

oval-cordate—(of the petal) longer than broad, rounded at the apex, notched at the base.

ovary—the five-celled chamber below the styles, which contains the ovules and later becomes the core of the fruit.

ovate—tapering to the apex, rounded and broadest at the base.

Pedicel—the stalk of a flower.
peduncle—the axis of the inflorescence (see *Bourse*).
petiole—the stalk of a leaf.
pollen—the male spores, the slightly adhesive minute yellow grains shed by the dehisced anthers.
pubescence—fine hair or down.

Receptacle—the outgrowth of the apex of the pedicel, surrounding and fused with the inferior ovary.
recurved—curved downwards.
reflexed—abruptly bent downwards.
retuse—with a shallow notch at the rounded apex.
rimmed—having the margin abruptly turned downwards, forming a narrow rim.
rugose—covered with wrinkles formed by the veinlets on the upper surface of the leaf.

Sepal—one of the five triangular teeth or segments of the calyx.
serrate—having saw-like teeth, small sharp teeth pointing towards the apex.
stamen—one of the pollen producing members of a flower ; approximately twenty of them are inserted in whorls next to the petals.
stigma—the apex of the style, a small pale yellowish-green papillate surface which receives the pollen.
style—one of the five slender greenish filaments extending upwards from the centre of the flower and each bearing a terminal stigma.
style-column—the united basal portion of the styles.
style-junction—the point of divergence of the five styles at the top of the style-column.
sub—a prefix signifying under, almost, nearly, somewhat.
sub-acute—somewhat pointed.
sub-entire—nearly entire.
sub-glabrous—almost hairless.
sub-obtuse—somewhat blunt.
sub-ovate—(of a petal) tapering to the apex, broadest near the base but tapering to the claw.
subtend—to be attached or inserted immediately below (e.g. a leaf subtends an axillary bud).

Tetramerous—having the floral parts arranged in whorls of four (e.g. 4 sepals, 4 petals, 12 or 16 stamens, 4 styles).

Upfolded—having the surface folded upwards on the mid-rib, more or less V-shaped in section.
uprolled—having the surface curved upwards and inwards from the margin parallel to the mid-rib, more or less C-shaped in section.

Summary.

1. Previous literature dealing with the systematic description of the flowers of apple varieties is reviewed.

2. The inflorescence and individual flower of the apple are described.

3. A descriptive glossary of the technical terms employed is supplied.

4. Full tabular descriptions of the varietal characters of the inflorescence of fifteen English varieties are given.

ACKNOWLEDGMENTS.

The author has pleasure in expressing his thanks to Mr. E. A. Bunyard for assistance in regard to some of the older literature, to Mr. H. R. Hutchinson, Librarian of the Lindley Library, for facilities in consulting literature, to Mr. R. G. Hatton, Director of the East Malling Research Station and Mr. J. Bond, Head Gardener, Olantigh Towers, Wye, for facilities to examine the trees of many apple varieties.

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THE CORSICAN PINE (*PINUS LARICIO*, POIRET): A SUGGESTION TO THE FARMER

By A. H. HAINES,
Head of the Department of Forestry.

ON the majority of farms there is some land which is either waste or a source of unproductive expenditure. There is no necessity for this to remain so as it might be planted profitably with Corsican Pine which grows quickly, sometimes increasing in height as much as 3 feet in a year, and produces stakes and poles, useful for a variety of purposes, throughout most of its existence. Now, too, that many farmers own their land, they no longer enjoy the benefit of a supply of timber by the landlord, as was the custom on most estates, and the situation would be improved by having a homegrown source of material for fencing and repairs, to say nothing of a possible market for such produce.

The Corsican Pine, introduced into England about 170 years ago, is not so well known to the layman as the Scots Pine which it resembles in many ways, but it produces about 50 per cent more *volume* per acre and the poles are, as a crop, straighter and of equal quality. The property of the wood when the tree is grown on chalk is not so good as when it is grown on sand or heavier soils, but if the poles are peeled and *properly* creosoted they will last twenty years or more in the ground. The Forest Products Research Laboratory, Princes Risborough, Buckinghamshire, reports that it is apparently the easiest species to preserve among the more common conifers. In appearance it is like the Scots Pine to the extent that it bears its semi-cylindrical needles in pairs, has sub-terminal female flowers, and somewhat conical cones: otherwise its details are much larger—buds, needles, male flowers, cones and seeds—and the needles are green whereas those of the Scots are bluish-green. The best single characteristic distinguishing it from all other pines is the twist of the needles, and this especially enables it to be distinguished from the Austrian Pine, the needles of which are stiff and straight, like the teeth of a comb, whereas those of the Corsican tend to curl or twist in their upper half. The root system is very adaptable and can descend deep in loose soil, being a tap-root tree, or spread laterally in shallow soil, so that it is generally known as storm-firm.

These characteristics contribute to its catholicity of taste as to soil, and in an experience of the tree over a period of thirty years the writer has found it a successful proposition on practically all types of soil, from one that is thin overlying chalk to a moderately stiff land: very wet soils, however, are quite unsuited to it and it should not be planted at high elevations in west or north nor on soft ground. It is also well adapted for shelter belts and is tolerant of sea-breezes and smoke or fumes.

With regard to planting, the first consideration is the distance apart which is most economical. This depends in a great measure upon the use which can be found for the thinnings. If there is a use for stakes in fruit, flower gardens and glass houses and for trellis work of, say, 1 to 2 inches in diameter, then the planting distance may be as close as 4 feet apart. If, on the other hand, there is no call for posts under 3 or 4 inches in diameter, then 5 feet apart would be the best distance to plant.

At 4 feet apart 2,720 plants will be required to the acre and 1,740 at 5 feet apart. If hares and rabbits are not kept down it is advisable, before planting, to protect the area by erecting wire netting. The Corsican Pine is, however, unpalatable to the rabbit and it may be possible to grow it successfully without protection, which would save the biggest part of the outlay in establishment of the crop.

Supposing that it is deemed necessary to fence, then the following specification is the cheapest. Straining posts, and roughly sawn or cleft stakes for intermediates at intervals of 10 feet: few of the former are required where the fence runs straight, but one is necessary at every corner or irregularity. The intermediates are pointed and may be driven in, but the straining posts must be properly set and strutted. A single strand of

Fig 1 — Entrance to Corsican Pine plantation

barbed wire is strained taut at a height of 3 feet and galvanized wire netting 42 inches wide, 18 gauge, and 1¼ inches mesh is hung from the barbs of the barbed wire and attached to the posts with staples. The barbs are bent back over the selvedge of the netting, thus avoiding any sort of tying. The 6 inches of netting left over at ground level is turned up at right angles to the fence on the outside and is anchored by means of sods or clods of earth laid upon it at intervals. It is not necessary to insert these 6 inches in the ground turned out an angle of 45 degrees, as used to be done, as they quickly become incorporated with the soil and weeds, and the immediate repulse to the rabbit in its efforts to burrow causes the pest to give up the attempt straightway. The cost of this fence, material and labour, is 1s. per yard run. After establishment, weeding is only necessary if the young trees are unable to compete with the weeds in height growth. It is generally necessary to go over the plantation and tread up any trees which have been wind-rocked.

intermediate inch class represented, and a maximum height of 40 feet. These may be valued, it is submitted, at 2s. apiece, at least, if utilized or sold as has been intimated :

1,400 poles	£140	0	0
Add those sold	36	2	0
Making a return of	£176	2	0 per acre

Which on the 3½ per cent tables equals a yearly net rental of £6 4s. 6d. (approx.) for a rotation of twenty years.

Appended are some details of a sample thinning made in 1931, twenty-three years after planting. Several poles of this size were sold for wireless aerials. Many of the poles cut at this time were, of course, much stouter and suitable for other purposes.

The plantation is absolutely free of weeds and undergrowth of any sort, so that replanting would be done at a minimum cost.

Year.	Age after Planting.	Annual height increment in inches.	Total Height. Feet.	Inches.
1908	—	—	--	--
1913	5	-	4	0
1914	6	21	5	9
1915	7	23	7	8
1916	8	31	10	3
1917	9	27	12	6
1918	10	31	15	1
1919	11	25	17	2
1920	12	24	19	2
1921	13	19	20	9
1922	14	17	22	2
1923	15	17	23	7
1924	16	22	25	5
1925	17	21	27	2
1926	18	29	29	7
1927	19	29	32	0
1928	20	21	33	9
1929	21	12	34	9
1930	22	14	35	11
1931	23	10	36	9

The diameter at breast height was 4½ inches and the taper slight.

In conclusion, a few words of caution should be added. As has already been said the Corsican is a very bad transplanter and, in inexperienced hands, it is often a difficult matter to get the crop " going " : for this reason small plants will succeed better than large ones. Even the foresters of the Forestry Commission lose a high percentage of plants and the tree's habit of " hanging fire " for a couple of years after planting might depress the uninitiated. Success depends on an abundance of fibrous roots at the time of planting, hence the desirability of frequent transplanting in the nursery : a good supply of " humus " manure will very greatly assist this. It is best to move transplants each year in the nursery so as to produce $x + 1$ year transplants and—as it suffers greatly if the roots are allowed to dry out—plants should not be obtained from a distance which would involve a long period of desiccation. If there is a home-nursery it is best to

purchase seedlings (2 year) and " line out " at home at least once before planting, thus producing 2 year 1 year ; or 2 year 1 year 1 year plants (i.e. 2 years in the seed bed and 1 year in lines, or 2 years in the seed beds and 1 year in lines and transplanted again for another year in lines). Possibly a co-operative nursery could be started for this purpose : bought transplants generally give poor results principally because of the drying of the roots.

According to the experiments of the Forestry Commission, early planting, that is before the end of January, gives the best results. There are all sorts of strains of Corsican to be met with nowadays, and various mainland similarities are being passed off as Corsican, so that the provenance or authenticity of the trees is an important point.

HORTICULTURAL ACCOUNTS

By JAMES WYLLIE,

Department of Economics.

HORTICULTURAL account-keeping can be conveniently discussed under four headings, viz. Objectives, Valuations, Accounting Methods, Interpretation and Use of Results.

OBJECTIVES.

A very common mistake, especially amongst those who know more about the academic than about the practical side of horticulture, is to *take for granted* that the keeping of accounts is essential to maximum efficiency, to *assume* that a farmer who makes a living without keeping accounts—as some farmers do !—would make a still better living if he kept them. The very first question that should be attempted in dealing with horticultural accounts is two-fold and should be made compulsory, viz. (1) what is the objective (or objectives) in keeping accounts and (2) what are the chances of that objective (or these objectives) being reached ? The objectives in account-keeping fall under three main heads.

(1) Accounts may be essential in order that a reliable profit and loss account and balance sheet may be prepared each year. For example, in the case of joint-stock companies or of partnerships such annual statements must be made up. Here the objectives are (*a*) to show the profit or loss on the year's working and (*b*) to show the position at the end of each financial year as regards assets, liabilities and capital ; and there can be no doubt that these objectives can be, and are, realized. But to the great majority of horticulturists these objectives make no appeal whatever, for very obvious reasons. It is true also that wherever money has been borrowed, either through a bank or in any other way, the lender who begins to have any doubts on the matter is entitled to ask for a statement of the financial position of the borrower and such a statement would undoubtedly be helpful in the event of still more money having to be borrowed. It is probably too true that many horticulturists are working partly on borrowed capital but it can hardly be expected that much enthusiasm will be shown in account-keeping if the chief objective is merely to satisfy those from whom money has been borrowed.

(2) In the second place, accounts are of great importance from the Income Tax point of view, but here again occupiers of land are in a special position. Farmers, and to a large extent horticulturists as well, have the option of being assessed upon the " annual value " of the land and are not *compelled* to keep accounts in order to satisfy the income tax authorities. On this basis, the majority of land occupiers are automatically exempted from paying any income tax at all, no matter what their actual profits may be. From this point of view accounts are useful only in bad times, because the occupier of land has the option of being assessed either upon annual value or actual profit, as shown by accounts, *whichever is the lower*. Three classes can be distinguished here, viz. (*a*) horticulturists whose " annual value " is so low that they are never liable for any income tax, (*b*) those who may be liable to pay income tax on the annual value basis, but who can claim to pay on the basis of profits in the event of the profit being less than the annual value of

the land, and (c) those who must pay under Schedule D, that is, on profits, this class being comparatively small in number. Again, there is no doubt that this objective in account-keeping can be reached, but so far as the great majority of horticulturists are concerned they are not likely to become really interested in accounts if the chief objective is to minimize the income tax payments: it is an objective based essentially upon depression rather than upon prosperity, upon keeping down losses rather than upon increasing profits. Nevertheless, it is at least possible that it might prove to be a blessing in disguise if all horticulturists were compelled by law to keep proper accounts for income tax purposes just as all other business people have to do. But this brings us to the third objective in account-keeping.

(3) Every business man, whether engaged in producing broccoli or boot-laces, tomatoes or table-knives, mushrooms or motor-cars, is constantly striving to increase his profits and the really vital question is: How can accounts be used to further this end? The farmer or horticulturist is quite entitled to maintain that the ordinary mercantile method of keeping accounts, no matter how accurate it may be, does not give him the slightest help in finding out where he might strengthen his management: in fact, it does not even try to do so. Nor will it do to *assume* that accounts *must* be useful from this point of view. The plain fact is that they are very often made up in such a way that the owner of the business does not even understand the accounts, let alone use them: all he can understand is that his profit or loss is said to be so-much for the year. There is not the slightest doubt that here lies the real explanation of the farmer's apathy, not to say antipathy, towards account-keeping. Common-sense tells him that merely to know that his annual profit or loss is so-much does not help in any way towards discovering some means by which the profit could be increased or the loss decreased. Make no mistake about it: as regards the great majority of farmers and horticulturists, the case for account-keeping stands or falls according to whether or not it can be conclusively shown that it will help the management in its struggle to make the organization and running of the business more efficient and therefore more profitable.

The importance of considering first of all the objectives in account-keeping will now be clear, because the method of accounting to be adopted must depend upon the objective. It is not sufficiently realized that if the only object is to find the profit or loss on the year's working then accounting, in the proper sense of the term, is hardly necessary. What we have to do is to devise, if we can, a method of accounting that will enable us to reach the third objective above-mentioned and we must show, if we can, *how* that objective will be reached by the method devised. Statements to the effect that no business can be "well-conducted" unless it keeps systematic accounts, that accounts are very useful in detecting leakages and in showing where profits and losses are being made and so on leave the successful non-book-keeping horticulturist quite cold and he is fully entitled by way of reply to ask: Well, show me just exactly how and where accounts will help me to make more money!

VALUATIONS.*

Accounts are normally based upon a period of one year and this gives rise to a complication of much importance, because the profit or loss shown by the accounts is not, as so many people imagine, an actual *fact*, but merely a careful *estimate*. For example,

* It should be clearly understood that this discussion deals only with valuations *for accounting purposes*. It does not follow that valuations for tenant-right purposes or for compensation claims under the Agricultural Holdings Act or for death duties will or should be made on the lines suggested. The essential object here is to make the annual valuations in such a way that they will give the maximum assistance in the realization of the accounting objective just mentioned.

here is a condensed statement of the results on a purely horticultural holding for the year 1931-32 :

	£		£
Valuation at 1 October 1931 ..	4,807	Revenue during 1931-32	3,518
Expenditure during 1931-32 ..	2,992	Valuation at 30 September 1932 ..	4,480
Profit	199		
	£7,998		£7,998

In this case, it is clear that the final result depends partly upon *facts* (expenditure and revenue) and partly upon *estimates* (opening and closing valuations). In other words, the profit could be increased by no less than £224 or over 100 per cent by increasing the closing valuations by 5 per cent, whereas by taking 5 per cent off these valuations the profit would entirely disappear. It is not too much to say that so far as *annual accounts* are concerned the final results can be completely distorted by judicious manipulation of the valuations and hence it is imperative that the making of these valuations should receive very careful consideration. On the other hand, it is equally true that *over a period of years* it is only the first and the last valuations that influence the net results over the whole period, since all the intermediate valuations are automatically cancelled out.

Date of Valuation. An annual valuation being at best no more than a necessary evil in account-keeping an important consideration should be to obviate the need for valuation at every possible point. Some at least of the difficulties and drawbacks can be side-stepped by making the valuations at Lady-Day (or even later) rather than at Michaelmas. The latter date falls right in the middle of the horticultural year : many market garden crops will be still on the ground, a large part of the apple crop still on the trees or in the store, blackberries and loganberries still on the bushes, whereas at Lady-Day (or better still 30 April) most, if not all, of these crops will have been realized. It is true that there will be more cultivations to value at Lady-Day than at Michaelmas but even so the case is simpler because there can be only one possible basis on which to value cultivations, viz. cost price, compared with at least three possible bases for Michaelmas crops. If the accounting year is made to run from Lady-Day to Lady-Day (or thereabouts), the harvesting and realization of the season's crops will fall almost entirely within a single accounting year, whereas with Michaelmas valuations they are spread over two accounting years. The greater the emphasis that is going to be placed upon *annual* results the more important this point is ; it becomes comparatively unimportant if the results are to be averaged over a period of years.

Live Stock. It is not necessary to say much about the valuation of live stock, chiefly horses, pigs and poultry. Unless under very special circumstances, these should be valued as nearly as possible at current market prices.

Equipment. The valuation of machinery and implements, buildings and other mechanical equipment has been fully discussed by the writer elsewhere* and readers may be referred to that discussion for full details of the method suggested. Briefly, it is this : (1) Estimate the probable working life of each machine (or building) or group of machines ; (2) estimate the probable scrap value of each unit ; (3) calculate the annual percentage depreciation which must be used in order to write down the original cost to scrap value during the working life, upon the " diminishing value " or " reduced instalment " basis. In horticulture, as in agriculture, most people think that a deprecia-

* " Calculation of the Annual Cost of Farm Machinery and Implements." *Jour. R.A.S.E.*, Vol. 93, 1932 (pp. 45-67).

tion rate of 10 per cent per annum means a life of ten years, whereas it takes no less than twenty-two years to write down £100 worth of machinery to a scrap value of £10 at 10 per cent per annum on the diminishing value basis, which is the basis almost invariably used by agricultural valuers.

Consumable Stores. Foodstuffs, manures, spraying materials, coal, coke, chips, punnets, trays, boxes and a variety of other consumable stores should generally be valued on the basis of their cost price. The difficulty here consists in getting accurate quantities or numbers of the various stores rather than in deciding what value is to be attached to each item.

Crops. It is in the valuation of horticultural crops that the real difficulties arise and for this purpose crops can be divided into two classes, viz. (*a*) those that occupy the ground for only one year or less and (*b*) those that occupy the ground, partly or wholly, for anything up to a hundred years or more. As regards the first class—*potatoes, broccoli, savoys, beet, parsnips, etc.*—the case is fairly simple. If the valuation is made at Lady-Day (or later) the bulk of the previous season's crops will have been realized and it will be possible at that date to estimate with considerable accuracy what the remainder, if any, is likely to realize. (In practice, it may be possible to " hold open " the valuation for several weeks so that it may be based upon amounts actually realized.) At this date, cultivations for the current year's crops should be valued on the basis of cost price, actual or estimated.

At Michaelmas, however, most of these " annual " crops will still be on the ground and it is a much debated point whether they should be valued on the basis of cost price or of estimated market value. As to the latter, there are two " unknowns " : first, the price at which the crop will ultimately be sold and, second, the quantity that will be available to sell—there may be an excellent crop of Christmas Cabbage at Michaelmas and yet absence of demand may result in most of it being fed to cattle or sheep, while a piece of broccoli may look very promising at Michaelmas and yet be completely ruined by a spell of frost. There can be little doubt that in all cases in which it is utterly impossible, within even very wide limits of accuracy, to say what the crop will ultimately realize the Michaelmas valuations should be based upon cost, with the proviso that where the crop is practically a failure it should be written down below cost—a badly diseased crop of potatoes may quite fairly be valued at less than its cost price. It should always be kept in mind that a valuation is required for two purposes, viz. (1) as a basis for the calculation of the annual profit or loss and (2) as a basis for the calculation of the " capital worth " of the business at the date of valuation. The accountant must be ever on his guard against " passing " a balance sheet which contains fictitious assets.

The next case in order of simplicity is that of *strawberries*, a crop which occupies the ground for a period of about four or five years, the first or " maiden " year being entirely, or almost entirely, unproductive. The two preliminary questions that have to be answered here are : (1) About what date is the line to be drawn between the maiden year and the first cropping year, between the first and second cropping years and so on ; and (2) on what basis is the cost of the maiden year to be apportioned over the cropping years ? As to the first, it is convenient, and also in accordance with the grower's objectives, to make the " strawberry year " end just after picking has been finished and the straw cleared away, that is, about the end of July. As to the second question, it is reasonable to apportion the maiden costs on the basis of the relative productive capacity of the cropping years. Assuming a three years' life, perhaps 35 per cent might be charged to the first crop, 40 per cent to the second and 25 per cent to the third, bearing in mind that the third crop will have to bear the cost of grubbing up. Hence, at the Michaelmas

next following the end of the maiden year, the valuations would include (1) the cost of the maiden year and (2) the cost of work done after about the end of July on account of the first crop ; at the following Michaelmas, there would be included (1) the cost of the maiden year, *less* the proportion written off and (2) the cost of work done after about the end of July on behalf of the second crop and so on. Should the valuation be made at Lady-Day the same principles can be followed.

With the procedure outlined above, it is assumed that the cost of taking up, and the price realized for, any " runners " that may be sold will be kept in a separate statement and not confused either with the cost of the maiden year or with sales of strawberries.

Rather more difficult is the case of such crops as *raspberries, loganberries, blackberries, gooseberries, black and red currants,* because here not only may there be the added complication of wire work (e.g. blackberries) but also the crop may be interplanted during its early years (e.g. black currants) while, in addition, the life of the crop is more uncertain than with strawberries. Nevertheless, the same general principles can be applied as in the case of strawberries. The cost incurred in the maiden year (or years), including the cost of wire work, is an overhead charge which must be allocated over the cropping years according to the estimated cropping life, either uniformly or upon an ascending and then descending scale, after allowing for the estimated value of the wire work when the crop is grubbed up. It is still necessary, however, to deal with several problems that arise here for the first time.

First, care must be taken not to include the cost of replacing stools or bushes that have died or of mending wire work as capital expenditure. Such expenditure is a replacement cost, it should be charged against the year in which it is incurred and not carried into the valuation at the end of the year. Second, where the crop is interplanted, e.g. potatoes between black currants, all the costs that belong specifically to the interplanted crop—seed, manures directly applied, planting, harvesting, etc.—together with a proportion of the cost of cultivations and of rent should be charged to that crop and the remainder charged against the main crop. On this basis, the valuation of the main crop would ignore any profits or losses made on the interplanted crop. On balance, this would appear to be the soundest basis to adopt, although it may be urged that the object of growing an interplanted crop is to minimize the capital investment in the main crop. Third, there is the cost of grubbing, which is a much more important item than in the case of strawberries. To the accountant this presents a nice little problem because it is an example of what is essentially an overhead cost arising *after* production is finished. Several courses are possible, but perhaps the most practicable is to ignore the cost of grubbing until it is actually incurred and then show it as a separate item in the profit and loss account so that allowance can be made for it in reviewing the results over the whole cropping period. Lastly, since the cropping life of these crops is difficult to forecast at all accurately, it may happen that the crop has to be grubbed up before the cost of the maiden year (or years) has been completely written off. In this case, also, the balance should be shown as a separate item in the profit and loss account, for the reason just mentioned.

No apology should be necessary for the somewhat general terms in which the valuation of these bush-fruit crops has been sketched. To have dealt with each crop in detail would have required the whole of the space given to this article. All that has been attempted is to outline the general principles on which such crops should be valued *for accounting purposes.*

And now we come to the most difficult case of all, that of *cherries, apples, pears, plums,* etc., which are slow in coming to maturity, but which remain productive for thirty, sixty or even a hundred years. Such crops are generally planted by land-owners rather

than by tenants (except where the Evesham custom is in vogue) and in due course they will add considerably to the selling or letting value of the land. Is it possible that these circumstances offer a loop-hole through which we can escape the valuation difficulties that loom so large in front of us? With bush-fruit it has been practicable to link up the valuation with the actual cost but this method breaks down completely in the case of top-fruit, chiefly because of the long maturing period, during which a variety of crops are interplanted or grazing carried on with an increasing amount of " interference " from the fruit trees. Fortunately, there are many cases in which the valuation of top-fruit does not arise.

For example, if a farmer rents a farm with an established orchard of top-fruit the rent paid will include the increased value of the land due to the orchard and so far as his accounts are concerned no orchard valuation is required: all that is necessary is to decide upon a fair apportionment of the rent between the orchard and other crops. Similarly, if an owner-occupier begins to establish an orchard of top-fruit he may quite reasonably regard all the planting and other expenses as being estate rather than farming expenditure, that is, he may look upon such expenditure as being incurred just as much with a view to increasing the value of the land as to bringing in ordinary farming profits.

An alternative method of approach is this. Put aside for the moment the need which may arise for arriving at some valuation figure for accounting purposes and lay the emphasis upon keeping as complete a record as possible of everything that has been done to Cherry Orchard A or Fruit Plantation B. For example, a ten-acre pasture field is planted with cherry trees. For a year or two grazing can be carried on almost as usual, then gradually the cherry trees will require more and more preferential treatment, that is, their well-being must be placed first and the pastures regarded essentially as a bye-product in cherry production. In a few years' time a small crop of cherries will be picked, increasing year by year until the trees have reached their maximum bearing capacity at the age of twenty years or more. Again, a ten-acre arable field may be planted with apples of different varieties and crops such as potatoes, gooseberries, raspberries, etc. interplanted. For several years the latter crops will yield a more or less steady annual return while the apple trees will yield nothing, after which the importance of the inter-planted crops will gradually diminish until they disappear altogether while the apple trees will be steadily advancing towards maximum production at the age of fifteen or twenty years or more.

In such cases, it seems quite impossible to make an annual valuation upon any other than a highly arbitrary basis, depending mainly upon the custom of the district, but from the management point of view the first essential is to have a complete history of these two ten-acre plots. This point will be more fully discussed under the head of accounting methods.

And there we must leave this particular section of valuation. No one is more fully aware of the omissions than the writer himself: nothing has been said about whether or not interest should be charged while top-fruit is being established or about the claim, sometimes made, that a cherry orchard must bear a charge for " loss of profits " from crops that would otherwise have been grown, and so on; but sufficient has been said to indicate the way in which top-fruit valuations, where necessary, can be fitted into the accounting system.

Methods of Accounting.

It is not proposed in this article to give a detailed description of horticultural accounting, but rather to discuss the general principles on which the accounts must

be constructed if they are to be of the maximum help to the management. The problem may be stated in this way. Horticultural production is admittedly a very complex process: crops follow one another in almost bewildering order and whereas the general farmer is quite reconciled to having a considerable portion of his land lying idle for several months in the year the horticulturist's object is to keep the land always busy, that is, always with some crop or other. And while it is true that even in general farming some difficult problems arise whenever an attempt is made to prepare separate crop accounts—allocation of manurial residues and beneficial cultivations, treatment of straw and other bye-products, etc.—in horticulture the problems are still further complicated (*a*) because crops are regularly interplanted with one another, (*b*) because it is quite usual to have at least three crops in two years off the same ground and (*c*) because definite rotations of specific crops are the exception rather than the rule. It can be said therefore that any attempt to apply a *complete* system of cost-accounting in horticulture is foredoomed to failure. However, we are going too fast: before there can be any question of applying any method of detailed accounting we must consider the extent to which an ordinary financial statement, based upon simple financial records of expenditure and revenue, will satisfy the third requirement already mentioned, that is, help the management in its struggle towards higher efficiency and better profits.

Here, for example, is the annual statement of accounts prepared for the horticultural holding already mentioned.

Statement of Accounts for Year ended Michaelmas, 1932.

Dr.	£	£		£	*Cr.* £
Opening Valuation		4,807	*Revenue:*		
Expenditure:			Glasshouse produce	544	
Pigs purchased	48		Plants and flowers	177	
Implements ,,	17		Strawberries	307	
Tractor ,,	63		Blackberries and loganberries	438	
Foods ,,	180		Apples	393	
Art. Manures	111		Pears	100	
F.Y.M. ,,	78		Other Fruit	270	
Seeds ,,	148		Potatoes	406	
Straw ,,	35		Other Vegetables	551	
Stores ,,	217		Pigs sold	255	
Wages	1,680		Hire work	71	
Rent and Rates	120		Sundries	6	
Insurance	7				3,518
Water	32		*Closing Valuation:*		4,480
Implement Repairs	36				
Tractor Repairs	22				
Shoeing and Harness Repairs	13				
Railway Carriage	78				
Tractor Hire	10				
Sundries	97				
		2,992			
Profit for Year:		199			
		£7,998			£7,998

Now there can be no doubt that this statement is of very great interest, although as already indicated it would be a mistake to attach too much importance to the net result. Further, it told the owner of this business a good many things which he did not know before. For example, he did not know that the cost of manual labour formed no less than 56 per cent of the total expenditure, nor that the total revenue represented only 76 per cent of the average valuations, nor that rent comprised no more than 4 per cent of the total outgoings, nor that the calculated profit was insufficient to pay even 5 per cent on the capital invested. But once having aroused his interest, does this statement give any guidance in answering the questions which he will immediately ask? He will say: Do you think I am spending too much on labour? Do you think I should spend more (or less) on manures? Can you tell me what profit, if any, I made from the glasshouses? How much money did the pigs lose? and so on And to each and every question the statement provides not even a vestige of an answer, and the farmer is left in much the same position as he was before, except that he may become "panicky" over the high percentage of labour and decide that the labour bill *must* be cut down—a decision that might be entirely wrong.

And now it will probably be urged that by *comparing* the above statement with similar statements from other horticultural holdings some useful indications could be obtained as to where improvements could be made. And immediately the farmer will ask: Are these other holdings cropped in the same way as mine, have they the same proportion of "glass," the same proportion under blackberries, the same proportion under a fruit "nursery"? Unless he can be assured that the other holdings do in fact closely approximate his own holding as regards size, general lay-out, composition and so on, can he be blamed if he attaches little or no importance to the comparisons? It is indeed only too true that facile comparisons are certain to do far more harm than good, and in horticulture especially it is extraordinarily difficult to get even a small number of holdings that would yield simple financial statements which could be validly compared.

But there is no need to labour the point. Such statements *are* interesting, they *do* tell the farmer a great deal that he did not previously know, *but* as guides towards more efficient management and higher profits they are of very limited value.

Must we conclude therefore that a simple financial statement is practically useless? On the contrary, it is fundamentally important because it provides an indispensable *foundation* on which it is possible to construct a system of accounting which would answer *some* of the questions on which the management may be urgently in need of reliable information. But a *single* financial statement is a foundation in another sense. It is generally agreed that it is very dangerous to base any conclusions, as to what should or should not be done to improve the management, upon the results of a single year and about the only good reason for preparing a statement for a single year is that it is necessary to have a first year before we can have a second and a third. Even simple financial statements have a certain cumulative value: they become more and more interesting and invite more and more questions the longer the period they cover. Now we have to consider if it is possible to put some flesh on to the bare bones of the simple financial statement so that it will be able to talk to the farmer in language which he can understand.

It has already been said that it is virtually impossible to prepare separate cost accounts for each and every kind of crop grown on a typical horticultural holding but this does not mean that cost accounting is entirely impracticable. There are some crops,

such as strawberries and blackberries, for which separate accounts can be prepared with very little trouble and with a high degree of accuracy. This applies also to various *sections* of the holding, such as glasshouses, a fruit nursery and a mixed fruit plantation. In these latter cases, it is more correct to speak of "departmental" or simply "detailed" accounts rather than of cost accounts because it will generally be impossible to get costs and profits down to a *per unit* basis: to get separate costs per unit for tomatoes and chrysanthemums grown in the same house would involve so many highly arbitrary apportionments that the figures would not be at all convincing and, in any case, would have little practical value.

Before going any further, two criticisms of this detailed accounting must be noticed. First, it is said that a horticultural holding must be regarded as "a one and indivisible whole," that the various crops and sections are mutually and inseparably interdependent. But consider the holding already mentioned. Pigs are kept and in 1931-32 caused a loss of £47: had there been no pigs the total profit would have been increased by at least £40. There is in fact no inextricable connection between the keeping of pigs and the production of asparagus, broccoli, or red currants. Again, on this holding over £1,300 is invested in glasshouses which can be, and are, run as an independent unit, while a fruit nursery has recently been established. Can it be seriously suggested that the efficiency with which potatoes and blackberries and apples can be grown will necessarily be raised by virtue of the existence of a fruit nursery? The claim that a horticultural holding cannot be split up into its component parts *for purposes of investigation and diagnosis* simply will not stand examination.

Second, it is said that the fact that a crop or section made a profit (or loss) in 1931-32 is no guarantee that it will do so in 1932-33 and that *therefore* detailed accounts can be of little or no use. This criticism is based upon a complete misunderstanding of the real function of account-keeping. All that accounts can be expected to do in this connection is to indicate the lowest possible cost at which a certain crop can be economically grown or a certain section efficiently run, under existing conditions, and it must then be left to the management to decide whether or not the future monetary returns are likely to be high enough to make production worth while. Accounts cannot work miracles: they are not, and never will be able to say what market prices will be next year or the year after: in fact, they do not even try to do so. This misconception is responsible for much of the antipathy against detailed accounts and until it is cleared away it is impossible to see them in the proper light.

The *method of accounting* which the writer has in mind can be illustrated by reference to the financial statement already given: no attempt can be made here to discuss the purely technical aspects of the work.

First, a general survey is made of the holding, in order to decide what *crops* and *sections* are suitable for separate analysis. To begin with at least, it may be advisable to select only one or two crops and one or two sections and to put the remainder into a general or "omnibus" account. For example, we might decide on (1) Strawberries; (2) Blackberries; (3) Glasshouses; (4) Mixed Plantation A and (5) Market Garden Crops B.

Second, the *revenue* side of the financial statement must be analysed so that the correct amounts can be credited to the detailed accounts, the remainder going, in as much detail as possible, to the omnibus account. This part of the work is very simple and calls for nothing more than systematic analysis of all sales. It should be remembered, however, that numbers and quantities sold, as well as prices, should be entered in the detailed accounts, with a view to obtaining reliable data of yields per acre, selling prices per lb., etc.

Third, the *expenditure* must be analysed on the same basis although here of course the work is rather more complicated. It will be necessary to make up separate ledger accounts for each of the expense items and the " balance " in each of these accounts must then be apportioned over the various detailed and omnibus accounts. In some cases, such as manures and seeds, apportionment can be done very easily and very accurately ; in others, such as manual labour and consumable stores, it will be necessary to keep suitable " disposal " records throughout the year, e.g. time sheets for workers, tractor sheets, records of spraying materials, etc. It is not possible to discuss the records and the methods of apportionment in any detail but it may be said that the foundation for reliable expenditure-apportionments is the worker's time sheet which he must be trained to keep for himself.

It may help to bring things to a clearer focus to show two actual " detailed " accounts, one for consumable stores (an " expense " account) and one for Blackberries (a " productive " account).

CONSUMABLE STORES.

Dr.											*Cr.*
1931		£	s.	d.		£	s.	d.	£	s.	d.
29 Sept.	To Valuation ..	136	14	4	By Sundry Sales				6	17	0
	,, Sundry Purchases ..	224	4	8	,, ,, Accounts :						
					Tractors	13	1	6			
					Fruit Nursery ..	4	8	0			
					Glasshouses ..	79	7	0			
					Blackberries ..	10	0	0			
					Strawberries ..	31	5	4			
					Horses		9	3			
					Pigs		9	6			
					Omnibus Account	126	7	7			
					Establishment ..		6	2			
									265	14	4
					1932						
					29 Sept. By Valuation				88	7	8
		£360	19	0					£360	19	0

Note : In practice, the account would give the *details* of each item on the two sides.

BLACKBERRIES (AND LOGANBERRIES)—8 acres (7 Cropped).

Dr.

1931		£	s.	d.	£	s.	d.
29 Sept.	To Valuation: (Crop and Wire work)				362	1	10
	,, Sundry Accounts:						
	Man Labour	226	4	5			
	,, (F.Y.M.)	8	0	9			
	Horse Labour	9	0	2			
	,, (F.Y.M.)	2	19	0			
	Art. Manure	1	13	0			
	F.Y.M. ..	27	9	0			
	Cons. Stores	10	0	0			
	Equipment	7	10	0			
	Rent and Rates	8	0	0			
	Rail Carriage	9	15	2			
	Establishment	8	0	0			
					318	11	6
	,, *Profit for Year*				52	16	9
					£733	10	1

Cr.

		£	s.	d.	£	s.	d.
	By Sales:						
	125 cwt. @ 42/9 per cwt. ..	267	17	1			
	5,325 "Tips" @ 55/- per 100	145	13	0			
					413	10	1
1932							
29 Sept.	By Valuation (Crop and Wire work)				320	0	0
					£733	10	1

Now it is important to see the above account for blackberries in the right perspective. It must be regarded as only one of a series of similar accounts going right *back* to the year in which the crop was planted and going *forward* from year to year so long as it is grown. It is true that this view cannot be built up in a year or two, but what we are concerned with here is the principle on which an account like this should be based. The value of detailed accounts is definitely cumulative and accounts over five years are far more than five times as valuable as accounts for only one year. This may seem a long time to wait but surely the horticulturist of all people is well accustomed to a waiting policy and he must not expect accounts to produce results any quicker than the crops themselves.

Now it will probably be objected that the suggested method of accounting will entail quite a lot of extra work. Of course it will. It is a characteristic of horticulture that a " lot of work " is required if there is to be any hope of earning reasonable profits and it is equally true that if accounting is to be made worth while it must receive its due share of work. On the other hand, it is nonsense to talk about the average horticultural holding requiring a full time clerk. Assuming that each worker keeps his own time sheet —and this is essential—all that is wanted is a regular three or four hours per week with a little extra at certain seasons and again at the end of the year.

But a final judgment on the cash value of detailed accounting must be postponed until we have considered our fourth heading : Interpretation and Use of Results.

INTERPRETATION AND USE OF RESULTS.

Perhaps the clearest way of dealing with this aspect of accounting—an aspect which does not get nearly as much attention as it deserves—is to refer again to the holding already mentioned, on which detailed accounts were kept for the first time in 1931-32.

On this holding, the total profit, according to the ordinary financial accounts, was £199 on a capital investment of about £4,700, but the detailed accounts showed that this total profit was the resultant of a number of profits and losses, as follows :

		£	£
Profits :	Glasshouses		223
	Blackberries and loganberries		53
	Strawberries		2
	General Fruit and Market Garden (Omnibus Account)		39
	Hire Work		5
			322
Losses :	Fruit Nursery	53	
	Pigs	47	
	Bees	2	
	Loss on old tractor sold	21	
			123
	Net Profit		199

The detailed analysis of the accounts at once exposed a serious inaccuracy in the total profit. This arose in two ways. First, the intention was to value the fruit nursery (from which not a single tree or bush had yet been sold) at cost up to date, but the estimated cost fell short of the actual by £53. Second, the valuation for strawberries at the end of the year omitted the manures applied to, and cultivations done for, the 1933 crop and hence the profit on this crop was at least £40 more than that shown above. These two corrections alone would increase the total profit by nearly 50 per cent. They would not have been necessary had detailed accounting been in regular operation. There is therefore no doubt that detailed accounts can give a *more* accurate indication of the total annual profit (or loss) than simple financial accounts and if any importance is to be attached to statements of annual profit (or loss) it is most essential that they should be as accurate as possible. Hence it can be claimed that the first and the immediate use of detailed accounts is to give a more accurate figure for the total annual profit (or loss) than is likely to be shown by simple accounts.

In the second place, it is surely of some value to know that a satisfactory profit has been earned on the glasshouses (including frames for growing a variety of garden and market garden plants). A profit of £223 on a capital investment of about £1,300 in buildings, frames, heating equipment, etc. is certainly encouraging although, of course, too much should not be made of the results for a single year. Again, the pig account showed a loss of £47, but analysis made it quite clear that the future prospects for pigs are far from hopeless. Eighty-five pigs were sold during the year at an average price of almost exactly 60s. apiece ; the total cost was 71s. 2d. and the loss therefore 11s. 2d. per head. It was known that, for reasons that need not be detailed here, some of the pigs did not do as well as they should have done, and this, coupled with the prospective rise in selling prices, gives reasonable hope for a much better result in 1932-33. On the other hand, the profit on sales of " all other fruit and market garden crops " amounting to over £1,700 was only £39 and at once invites the question : *Why* was it so low ? It is almost invariably found that a little experience of detailed accounting whets the appetite for more.

These two examples may serve to show that some useful information can be provided by detailed accounts even in the very first year, but we have now to consider the more general case : that in which such accounts are available over a period of years.

Consider the blackberry crop, which has had a considerable vogue in recent years, and let us suppose that the grower has detailed accounts over a period of five years. Sooner or later the question must be faced : Are blackberries doing me any good ? Should they be scrapped, extended or just maintained ? (And it is quite wrong to assume that a certain acreage of blackberries *must* be grown as an essential part of an efficient horticultural organization.) Now there may be some horticulturists whose business instinct is so highly developed that they can " smell out " where profits have been and are likely to be made, but it is fairly certain that the great majority cannot do so. This is just where detailed accounts come in to fill *part* of a big gap in the knowledge of even the most efficient manager. They will not tell him what the *market price* for blackberries will be next year or the year after—and that is of course a very important point—but they will help him to estimate very closely what the average *cost per acre* is likely to be : the probable average *yield per acre* can of course be obtained without detailed accounts. There are many examples in ordinary farming—no evidence of any kind is available from horticulture—where the detailed accounts show quite conclusively that the chances of making a profit in the light of even the highest selling prices that could reasonably be expected are practically *nil*, because of the high costs, and in such cases there may be nothing for it but to try something else. And there are also examples where the detailed accounts show that there would still be a profit with market prices at the lowest level that could reasonably be allowed for. Can it be denied that such information is of definite value in planning for the future ; or that what applies to general farming will not also hold good for horticulture ?

However, let us consider for a moment one of the implications in the above paragraph. It is assumed that the average cost per acre over the past five years can safely be taken as the probable average cost per acre during the next five years, but can it ? Of course, the cost per acre depends partly upon the current rates of wages, the cost of manures and spraying materials and so on and we can no more forecast the prices of these things than we can the selling price of the crop. But the cost per acre depends also upon what is called the efficiency of the management : with the same soil and the same price levels for labour, manures, etc. some growers have a much lower cost per acre than others. And so the question arises : Can the detailed accounts give any indication as to how *real* economies can be effected in production costs per acre ? This question, however, is less simple than it looks and it can be put more accurately : Could production costs be *altered* in such a way that a larger total profit could be obtained from a given acreage ? For example, greater economy in strawberry growing may call for more liberal manuring, more systematic treatment against insect and fungoid attacks, that is, *higher* costs per acre rather than lower. The ever growing emphasis that must be laid upon *quality* in horticultural products indicates increased rather than decreased costs per acre. Nevertheless, there can be very large differences in the *cultivation* costs per acre due simply to the different methods and machines that are in use and every effort must be made to keep cultivation costs at the economic minimum.

Now one of the greatest uses of detailed accounts is to show how imperative it is always to consider expenditure *in relation to* revenue, rather than to think of expenditure as something which can be judged by itself. Hence, we must be extremely careful in drawing any conclusions at all from production costs per acre ; what we should and can do is to trace out the ultimate effects of increasing or decreasing costs per acre upon the

final results. From this point of view detailed accounts would *help* to fill a big blank in horticultural history: over a period of years they would afford very definite evidence as to whether a high-cost policy, coupled with good yields of "quality" produce, or a low-cost policy with smaller yields of "ordinary" produce would be likely to yield the higher total profits. At present, the emphasis swings about: at one time, it is upon the greater value of high quality produce, at another, upon the high costs involved in getting such produce; whereas what we should do is to consider the one in relation to the other.

So far it has been assumed that the horticulturist will have access to his own accounts only but now suppose that some scheme could be introduced under which the results from different farms could be compared, year by year and period by period. Would such comparisons be likely to help in measuring the efficiency of the management on any given farm? The answer at the moment is very doubtful, and no definite opinion can be offered until it has been possible to obtain a number of detailed accounts from a number of different farms. For the present, the writer would prefer not to rely very much, if at all, upon this comparative method of using horticultural accounts—however useful it may have been found in general farming. It is obviously just as necessary to establish "standards of performance" in the orchard or market garden as it is in the cowsheds or poultry runs but the difficulties are much greater, chiefly because seasonal conditions, over which the farmer has little or no control, have a much greater influence in the former than in the latter cases.

Only a brief reference can be made to one aspect of detailed accounting which is of considerable topical interest. Canning factories have recently sprung up all over the country and fruit growers and market gardeners are being strongly urged to see to it that supplies of the right classes of fruit and vegetables are produced in sufficient quantities to keep the factories working on an economical basis. Now the writer has no intention of asserting that the market price of any commodity is or should be determined solely by its cost of production, but it is difficult to see how it is possible to fix "fair and reasonable" prices between growers and canners if no reliable evidence is available as to what it costs to produce, under conditions of reasonable efficiency, a ton of peas, of strawberries or of gooseberries. And there is no other way of obtaining such evidence except through detailed accounts. Further, the right time to collect the evidence is *now*, while the industry is, we hope, still in its infancy.

And now my space, although not my subject, is exhausted. I hope I have said enough to show that there is at least a case for detailed accounting in horticulture. At the moment, I am in much the same position in regard to horticultural accounting as I was fifteen years ago in regard to accounting on the general farm. As to the latter, I am more than ever convinced of the need for, and advantages to be gained from, detailed accounts and this must be my chief reason for suggesting that an attempt at least should be made to give them a thorough trial in horticulture.

COST PER UNIT AS A MEASURE OF EFFICIENCY

By M. A. Knox,
Department of Economics.

Before dealing with cost per unit as a measure of anything we must decide what we are to understand by efficiency in agriculture as difficulties arise from the emphasis which is laid in different quarters on what it is desirable to achieve. Should agriculture, for instance, aim at the greatest output of food per acre ; in other words should its economic efficiency be measured in terms of calories ? Should agriculture be regarded as the most suitable " life " for the greatest possible number ; in other words should its economic efficiency be measured in terms of the percentage of the total population to which it can give employment ? Should the energy which the human race spends in feeding itself be reduced to a minimum to allow time for its many other activities ; in other words, should economic efficiency in agriculture be measured in terms of output per man ?

Such questions lie perhaps more with the political than with the agricultural economist although some would say that the duty of the latter is to provide the material upon which the political economist—or should it be politician ?—can work.

Only by chance will any of the above views as to what constitutes economic efficiency in agriculture coincide with those of an individual farmer, *as a farmer*. To him economic efficiency is synonymous with maximum profit, and each, finally, wishes to obtain from the management of his farm the maximum profit which his conscience will allow.

Apart from general principles of economic efficiency or expediency which affect the industry as a whole, profit will depend on the success with which the individual controls the different factors of production which lie to his hands. Much of the assistance which detailed economic investigations can render to farmers lies in pointing to ways in which individuals can judge of their own efficiency in this direction and to this end they must have something with which to compare their efforts.

One of the objects of the investigation into Farming Costs of Production and Financial Results commenced by this department in 1923 was to obtain suitable standards by which economic efficiency in farming can be measured, e.g. to compare the reliability as measuring sticks of such figures as cost per unit, profit per unit and so on. Farmers are interested in such an analysis as affording possible clues as to the measure of success or otherwise with which each of the factors affecting such figures have been handled. Some of these factors will be outwith their control and at times it will be legitimate to turn the tables so to speak and measure how such factors handle farmers (*vide* a " Clay Farming Episode " in an earlier issue of this *Journal*).

How can we measure whether there has been waste of endeavour or material, or perhaps more often waste of the opportunity of using material or endeavour ? We can but " judge by results " and moreover we have to base economic standards on the achievements of the most successful men more often than on the results of controlled experiments. In such an industry as agriculture in which the conditions affecting individual farmers can vary so much, the economist, however, can rarely throw a bone to the industry in the shape of a single standard of excellence and consider his job is done. The argument that " what has been done you can do " has so often been cast in the

face of the farmer and so often fails under cross examination that the question " can you do what has been done ? " is often an important qualification to the standard itself.

This leads us naturally to the point that it is no use having a measure of efficiency at all unless farmers know, or can be shown, how best to analyse their own business so that this question can be answered. There is little point in knowing that someone had a less cost per unit or greater profit per unit and so on if there is no collateral evidence that the lower cost or greater profit can be achieved under one's own conditions. Admittedly, we can say that it is unlikely that a share of a competitive market will be maintained unless cost is screwed down to a certain level if we show that on the average it is the level which other producers attain. Much of the interest which producers have in seeing a number of comparative costs does lie here, for it is of small satisfaction to the individual producer to know that he is using his resources to the best of his ability if these resources are such that it is not worth his while struggling with them. To a milk producer on the top of Ben Nevis a cost of 6s. per gallon might measure exceptional efficiency, but the emphasis laid on the cost per gallon figure will have entirely shifted. Naturally in many ways comparison with other actual cases may best stimulate efforts to improve one's own position and there is more confidence in a standard as a practicable proposition if it is shown that it has actually been achieved by some one in similar circumstances.

As we have said, we can only arrive at our presumptive standards by finding out what has been a fair level of excellence in the experience of a sufficient number of producers. It does not follow that we must measure our standard of efficiency, for whatever effort it may be, at the *highest* level found in that experience. To do so, in some cases, would be too discouraging for the rank and file though no harm could come from pointing out that our standard had on occasion been bettered. Further, our standards may quite legitimately be changed from time to time as the average conditions alter or as average efficiency rises. Of course, it does not necessarily follow that we must always have a specific standard with which to measure efficiency. For instance in drawing attention to the need for controlling the issue of foodstuffs from barn or store we use as our standard merely the fact that a good business man knows what happens to what he buys or produces, added to the fact of course that we know that in this respect many farmers are *not* good business men and that such control *does* save money.

So much for measurements of efficiency in general; let us look at " cost " as a measure.

Much farm management analysis centres round the determination of costs of production. In general it is possible to arrive at the total cost of producing a farm commodity with very tolerable accuracy and in so doing to show the cost per unit of the individual items which make up that cost. As a means of ferreting out where some weakness in the management of a particular farm lies or the effect of particular conditions —which may or may not be under the farmer's control—such an analysis is well nigh indispensable. Criticism is sometimes offered on the ground that cost or profit in any one section of the farm cannot fully reflect the position which that section may hold to the farm as a whole, but nevertheless the analysis may prove surprising to the farmer whose impressions as to cost of, or profit from, any particular section do on occasion prove to be very wide of the mark. However important such a feature may occasionally prove to be, however, it has to be driven home that the main object is *not* to decide that, say, artichokes shall or shall not be grown, but how efficiently artichokes *can* be grown. Naturally the two hang together in many respects. We may show that as the cost of tractor work per hour depends very largely on the amount of work which the tractor can be given to do, a very useful standard is 1,000 hours work in the year, and such a standard will be in mind when to have or not to have a tractor is in question.

Cost per unit, that is cost per hour, per gallon and so on, is a familiar figure to the farmer and one on which he is tempted, if not sometimes encouraged, to base all sorts of conclusions. We have just mentioned cost per hour with reference to tractor work, but it is obvious that the value of a tractor's work cannot always be measured in terms of cost. One of the advantages of a tractor is the speed with which it can get through an urgent piece of work and this cannot be reflected in a cost per hour figure. In fact the faster it does the work the fewer hours are there over which to spread the total cost. This feature is perhaps most important in comparisons based on the cost per hour of horse work. A fast moving team will have a job done and be in the stable again, idle, while the slower mover will be only three quarters through the same job. The latter show a lower cost *per hour* merely because they work longer. The advantage is actually with the faster team since their driver can be doing another job while the other plods along behind his pair.

Much depends on the unit chosen. We feed the cow, for instance, but count the cost per gallon, yet the number of gallons we get from a cow is affected by many things other than feeding. Low food cost per gallon is not the result of one self-contained effort such as hitting the bull's eye with a single good rifle shot. It consists at a minimum of such diverse matters as the capacity to buy or produce foods at low cost, to buy or breed good cows, to control the feeding, to avoid disease and so on, any or all of which will affect the cost per gallon figure.

We have the further consideration that *cost* per unit takes account of *price* movements which may be beyond the individual producer's power to control. A higher cost of foods per gallon in one year, for instance, may be due solely to increases in the price of purchased foods and not to any reduced managerial efficiency on the farmer's part.

The problem might well be thought to be complicated enough already, but there are still two important aspects of the cost per unit basis for measuring efficiency.

Firstly, it is not so much profit per gallon as total profit, quite irrespective of the actual gallonage handled, at which the milk producer will aim. If he can sell all his milk at 1s. per gallon, an individual producer will be better pleased with 1,000 gallons at a cost of 10d. per gallon than with 600 gallons at a cost of 9d. per gallon.

Secondly, the producer is interested in individual items of cost only in so far as they affect his total cost. They have no virtue in themselves and it is, for example, possible to propound figures which, without any change in the actual cost of items other than food, would show a lower food cost per gallon and yet the same total cost per gallon.

It may be interesting to show how such a result could be arrived at:

First Year: Average yield 700 gallons.

	per cow.	*per gallon.*	*percentage.*
Cost of foods	£21	7·20	58%
Cost of all other items	£15	5·15	42%
Total cost	£36	12·35	100%

Second Year: Average yield 660 gallons.

	per cow.	*per gallon.*	*percentage.*
Cost of foods	£19	6·91	56%
Cost of all other items	£15	5·44	44%
Total cost	£34	12·35	100%

Such an admittedly exceptional result would be due solely to the effect of changes in yield per cow and to the proportion which food cost bore to total cost, but what of the cost per gallon basis ? It is only one of the many ways in which the danger of attempting to divorce a single item from its context becomes apparent. Yet we must have cost per unit if for nothing more than as a *sign post.* For instance if the total cost of milk per gallon on one farm is 1s. and on another 1s. 3d., individual items of cost may have to be looked at before the reasons for this difference can be determined. If it is found that the cost of all items other than food amount to 5d. per gallon on both farms, but that one has a food cost of 7d. and the other, one of 10d. it will be fairly safe to confine attention to matters affecting feeding cost. The fact that the cost of items other than food was the same in both cases enabled one to rule out many of the factors which would otherwise affect the comparison of food cost itself. Our standard in effect becomes " 5d. plus food equalled 1s. per gallon," and *not* " food equalled 7d. per gallon," however paradoxical the difference in emphasis may seem to be at first glance. How false such a measure might be is clearly shown by the example given above in which the influence of outside factors on the individual cost per unit is given full play.

However familiar and important cost per unit may be in many directions it is seen therefore to have two main features which limit its use as a measure of economic efficiency :

(1) As a measure of the efficiency with which one particular factor is handled it suffers in that it can be directly influenced by matters which have no direct bearing on that particular factor. If yield affects our unit for example, all things affecting yield will influence our food cost per unit whether they have any connection with feeding or not. It is not to be inferred from this that it is a disadvantage to have a figure which brings together so many influences. From many points of view it is a decided advantage but the point here made is that as a measure of any *one* factor it has its complications which may be difficult to disentangle in terms of cost at all.

(2) As a measure of the combined influences of all factors it suffers in that it cannot reflect *all* matters which the farmer must take into consideration. It cannot cover those considerations for example which will lead a farmer to produce 1,000 gallons at a cost of 10d. per gallon rather than 600 gallons at a cost of 9d. and to that extent 10d. or 9d. have no significance from the point of view we are considering.

Cost per unit, then, rather falls between two stools as a self-contained measure. As we have seen, it has the further disadvantage that it can be definitely misleading if we pick out one single item and attempt, say, to compare cow-feeding efficiency on the basis of food cost per gallon without reference to total cost per gallon. And yet obvious enough is the importance of feeding cost in milk production and the cost of foods per gallon, or per cow, might appear on the face of it a definite enough measuring stick by which a farmer can gauge the efficiency with which his cows are being fed.

Lest the impression should be left that after ten years' work the economist is still hunting for his standards it should in conclusion be stated that he has had some success even if " cost per unit " in which the farmer happens to be so interested should appear to be hedged round with the economist's usual disclaimer—" other things being equal ! "

Fortunately there *are* standards other than cost per unit to which the farmer can turn, but cost per unit has been thought to be worthy of an article to itself just because it is such a familiar figure and one on which we are all at times tempted to place too much reliance as an indicator of how efficiently the farmer goes about his business.

PHOTOGRAPHY AS A HELP IN THE EXAMINATION OF CATTLE FOODS*

STRUCTURE OF THE POD AND SEEDS OF CANAVALIA SPP.

By M. N. Lucie-Smith

INTRODUCTION

Canavalia species are widely cultivated throughout the tropics and sub-tropics, many of them yielding edible seeds. The ability to identify fragments of the seed or pod under the microscope is of use inasmuch as the seeds of *C. ensiformis* have been milled in the United States for cattle-food,† while there is also the possibility of fragments occurring as impurities in other leguminous foods of tropical origin. In addition, according to Winton,‡ *Canavalia* seeds are used as coffee substitutes. Under present economic conditions the importation of such tropical seeds into this, and other, temperate countries appears likely to increase.

DESCRIPTIONS AND USES

The species investigated were the following :—

C. ensiformis D.C. The Jack Bean.—The pod is 10 to 14 in. long, about 1 in. wide, and contains between ten and fourteen seeds. It is long, smooth when dry, slightly curved, shaped like a sword blade, and has a small beak at the stylar end. In general shape the pod is similar to that of the Scarlet Runner or Long Bean, but is more oval in cross-section. The ventral suture is bordered on either side by two well-marked ridges or ribs which run the length of the pod. The pods are dry and hard at maturity, and, after dehiscence, the valves exhibit very marked twisting. The seeds in the " stuffed " pod are about ¾ in. long, large, oval, smooth, glossy, and flattened. They are always pure white in colour. The hilum, which is situated centrally on the ventral surface of the seed, is narrow and oblong, tapering slightly at the end opposite the micropyle, ⅜ in. long (about half as long as the seed), grey in colour with a brown edging, and is surrounded by the torn remains of the white membranous attachment to the funicle. The raphe and strophiole are only faintly discernible. The funicle itself is dark grey in colour, and resembles that of *Vicia Faba*, being narrow at its point of attachment to the pod and very broad at the hilum end.

C. ensiformis is the most widely cultivated species of *Canavalia*, and gives a heavy yield both of green herbage and of beans. It forms an excellent cover and green-manure crop, and is often used for forage. In the United States it is said to have given distinct

* This article is a continuation of a series published in former numbers of this *Journal* dealing with the microscopic examination of fragments present in cattle foods.

† Piper, C. V., " The Jack Bean." *U.S. Dept. Agric. Circular* 92, April 1920, pp. 10-11.

‡ Winton, A. C., " Microscopy of Vegetable Foods." New York, John Wiley & Sons, 1916, p. 258.

promise for ensilage, and has been tried for hay. The young beans are sometimes employed as a vegetable, while the seeds, after removal of the testa, have been used for human food, and also, roasted, as a coffee substitute. A medicinal organic substance, urease, also present in smaller amount in the Soy Bean, is extracted from the Jack Bean. At one time the seeds were regarded as possessing toxic properties, but investigation at the Imperial Institute* failed to find any deleterious matter. (According to Piper, however, a wild species, *C. virosa*, in India, has poisonous narcotic properties.)

Analysis of a sample of seeds showed 15·5 per cent water, 27·6 per cent protein, 3·2 per cent fat, 45·2 per cent nitrogen-free extract, 5·4 per cent crude fibre, and 3·1 per cent ash,† and a bean-meal for cattle-feeding purposes 11·48 per cent water, 23·75 per cent protein, 2·65 per cent fat, 50·37 per cent nitrogen-free extract, 8·75 per cent crude fibre, and 3·0 per cent ash.‡ Although the meal has not proved entirely successful experimentally,§ Jack Bean seeds may later prove to be of increasing importance in European commerce.

C. gladiata D.C. The Sword Bean.—The pod of the Sword Bean is similar to that of the Jack Bean, but shorter, broader, coarser, and more wrinkled and flattened. In this species the seeds are usually red or pink, rarely brown, and white only in one Japanese variety. They are large, over 1 in. in length. Unlike *C. ensiformis*, the hilum is nearly as long as the seed—the two species can always be distinguished by this characteristic. The Sword Bean is Asiatic in origin, and a quite commonly cultivated species in all parts of the tropics.

C. plagiosperma.—This is a cultivated species similar to *C. ensiformis*, but more climbing in habit. The pod is about 9 in. long, over 1 in. in breadth, and contains, on an average, ten seeds. It is broader, shorter, and more flattened than the pod of *C. ensiformis*. The seeds are pinkish to yellowish brown, and over ⅘ in. long. The hilum, as in *C. ensiformis*, is about half the length of the seed.

C. obtusifolia D.C. is a common tropical shore-plant. The specimens of pods and seeds examined were collected from the wild plants on the Cocal, a sea-beach in Trinidad. The seeds are much smaller than in the above-mentioned species, and are of a dull, dirty, chocolate-brown colour. The pod is about 4 in. long, and contains an average of four seeds, the seeds being about ⅗ in. long.

HISTOLOGY

The general histological structure is similar for all species examined, but, as is to be expected, the relative sizes of the corresponding cells in the various species differs according to the size of the seed. In this connection, however, it is to be noted that *C. obtusifolia* is an apparent exception, the cells of the testa (as may be seen from measurements given) being out of all proportion to the comparatively small size of the seed.

A.—THE POD has a simple, but interesting, microscopic structure.

(1) The EPICARP or outer epidermis consists of a single layer of small, thin-walled, cuticularized cells without intercellular spaces. These are often damaged, and are of very little diagnostic value.

* *Bull. Imp. Inst.*, Vol. XV, No. 4, Oct.-Dec. 1917, p. 505.
† *Dept. Agr., Trinidad and Tobago*, 1917.
‡ *Miss. Exp. Sta. Bull.* 39, p. 159, 1896.
§ Piper, C. V., loc. cit., pp. 10-11.

(2) The HYPODERM consists of a most characteristic single layer of closely packed sclerenchymatous cells. These cells are very long, and more or less oblong in shape, with a uniformly thickened and lignified cell-wall (which stains very brilliantly with safranin), and a very large cell-cavity. In cross-section, in the case of *C. ensiformis*, the cell-cavity is 30-60μ in diameter and the wall 15-20μ thick. These cells run in a direction oblique to the length of the pod, and form a fibrous covering which shows externally as an oblique " grain " on the surface of the pod. The hypoderm cells are readily recognized by their large size, uniform wall, and wide lumen.

(3) The MESOCARP which forms the main bulk of the tissue consists of :

(*a*) PARENCHYMA. A particularly uniform layer of thin-walled parenchyma with scattered patches of brown pigment occurs beneath the hypoderm. The parenchyma contains a few small vascular bundles. The simple character of the mesocarp in which there are only traces of bundles and fibres crossing the parenchyma is in marked contrast with the Earthnut (*Arachis hypogea*, L.)* where there is abundant crossing of fibres from one side of the pod to the other. A layer of crystal-containing cells occurs at the inner surface of the parenchyma.

(*b*) FIBRES. The inner portion of the transverse section of the pod is composed of two sets of fibre-cells running more or less at right angles to each other and obliquely to the length of the pod. The upper set runs in the same direction as the hypoderm fibres, and the lower set at right angles. This arrangement of fibres explains the twisting which occurs after dehiscence. Each set of fibre-cells consists of three or four layers. The upper set are tracheidal in nature with large round pits set in the wall in a linear manner, the lower set are typical narrow elongated fibre-cells.

(4) The ENDOCARP could not be distinguished in the dry pod.

The Ribs visible on the surface of the pod contain a well-marked fibro-vascular bundle. The elements of the vascular bundle are seen to be in the centre of the rib encompassed by a crescent-shaped cap of ordinary sclerenchyma.

B.—THE SEED.

(1) The SEED-COAT.

(*a*) The PALISADE layer or epidermis is composed of the thick-walled prismatic cells characteristic of leguminous seeds. The " light band " is narrow, but usually very distinct. The palisade cells of *Canavalia* species are characterized by :—

(i) *Their great length* as compared with the palisade cells of most other plants (e.g. *Phaseolus* spp., Fenugreek, Pea, Soy Bean, Gram, Mutter, and Cowpea), approaching that of the larger specimens of *Vicia Faba* and *Ceratonia Siliqua*, two leguminous seeds especially distinguished by the length of their palisade cells.† In each species eight cells chosen at random from preparations of the ground-up fragments of the testa were measured, and the following were the results obtained :—

	Variation.	*Average.*
C. ensiformis	142-190μ	169μ
C. gladiata	205-230μ	216μ
C. plagiosperma	129-139μ	134μ
C. obtusifolia	179-220μ	201μ

* Parkinson and Fielding, " The Microscopic Examination of Cattle Foods." Headley Brothers, 1930, p. 81.

† Parkinson and Fielding, op. cit., p. 77.

PLATE I

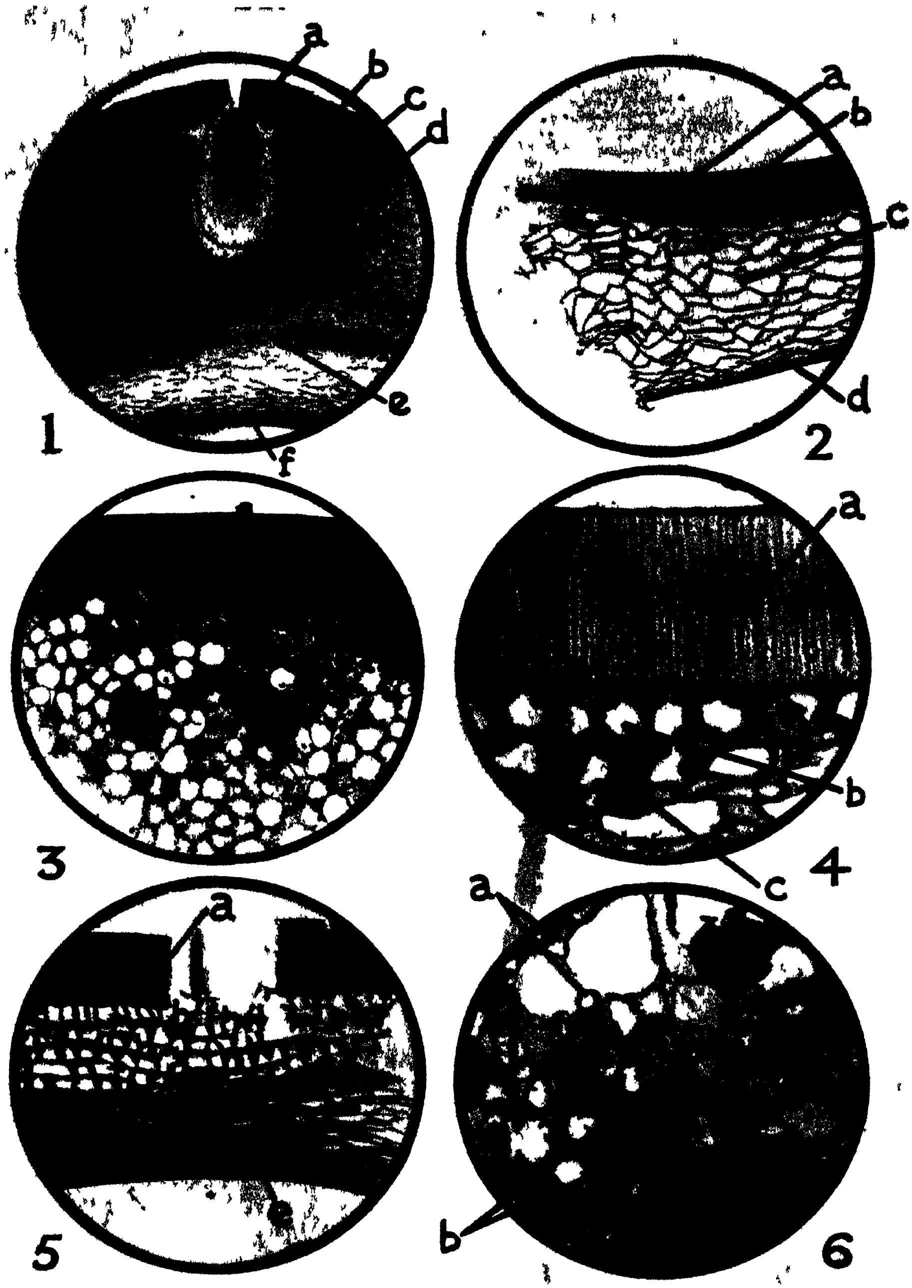

Fig 1.—*C. ensiformis*.—Section across testa in hilum region × 24. (*a*) Cells beneath hilum slit. (*b*) Double Palisade layer. (*c*) Sclerenchyma. (*d*) " Star-cells ". (*e*) Parenchyma. (*f*) Inner Epidermis.

Fig 3.—*C. ensiformis*. Section across cotyledon × 24.

Fig 5.—*C. gladiata*. Section across testa in body of seed × 24. (*a*) Palisade. (*b*) Column cells. (*c*) Transition. (*d*) Parenchyma. (*e*) Compressed parenchyma and inner epidermis.

Fig 2.—*C. ensiformis*. Section across testa in body of seed × 24. (*a*) Single Palisade layer. (*b*) Column cells. (*c*) Parenchyma. (*d*) Compressed parenchyma and inner epidermis.

Fig 4.—*C. ensiformis*. Part of section across testa in body of seed × 145. (*a*) Palisade. (*b*) Column cells. (*c*) Commencement of transition from column cells to parenchyma.

Fig 6.—*C. gladiata*. Part of section across cotyledon × 145. (*a*) Circular inter-cellular spaces. (*b*) Starch grains in cell.

(ii) *Their narrowness* in comparison with their great length. Width in the above-mentioned cells was as follows :—

	Variation.	*Average.*
C. ensiformis	15-28μ	21μ
C. gladiata	20-25μ	23μ
C. plagiosperma	18-20μ	19μ
C. obtusifolia	15-21μ	17μ

(iii) *The very narrow lumen.* This is of more or less uniform width in the majority of cases, but, in a few cells, a very slight bulbous enlargement of the cavity may be noticed at the base. (Such an enlargement is shown by the top-most cell in Fig. 4a, Pl. II.) In surface-view (Fig. 2, Pl. II) the palisade cells present, in general, a polygonal outline with thick porous walls and a very narrow cell-cavity, and this appearance, owing to the uniformly thickened cell-walls, does not vary greatly according to the depth of focus. [In this uniform thickening of these cell-walls *Canavalia* spp. differ from many leguminous seeds (e.g. Field Bean*).]

(iv) *The absence of pigment,* since the palisade cells are practically colourless.

A certain amount of variation in length and width occurs according to the position of the palisade cells in the testa. Where the palisade layer is doubled in the hilum region (Fig. 1b, Pl. I), the cells are shorter and wider than those composing the epidermis of the rest of the seed (Fig. 2a, Pl. I). (Compare Figs. 3 and 4a of Pl. II.) Patches of palisade cells occurring in fragments of the testa have a characteristic appearance under the low power of the microscope, resembling bundles of short, thick, highly refractive rods. This is well shown in Fig. 1, Pl. II.

(*b*) The Column Cells of the sub-epidermis are of the typical dumb-bell shape seen in the majority of leguminous seeds (Fig. 4b, Pl. I). Over the body of the seed there are up to four or more layers of column cells, but only the upper layers are strictly typical, as the underlying cells gradually lose their characteristic dumb-bell shape, finally merging into the parenchyma. This transition is shown in Fig. 5, Pl. I, and also in Fig. 4c, Pl. I. Beneath the hilum, however, the column cells are replaced by sclerenchyma with dark brown contents (Fig. 1c, Pl. I), isolated specimens of which, obtained from the hilum region of the testa, are shown in Fig. 6, Pl. II. These sclerenchyma cells give place to thick-walled fantastically branched or compound " star-cells " (Fig. 5, Pl. II) which form considerable tissue beneath the hilum (Fig. 1d, Pl. I).

Six cells taken from the typical uppermost layer gave the following measurements :—

	Length.		*Width at ends.*		*Width at neck.*	
	Variation.	*Average.*	*Variation.*	*Average.*	*Variation.*	*Average.*
C. ensiformis	32-49μ	42μ	15-45μ	34μ	12-20μ	16μ
C. gladiata	75-108μ	92μ	21-40μ	32μ	14-20μ	18μ
C. plagiosperma	48-52μ	50μ	20-35μ	28μ	12-18μ	14μ
C. obtusifolia	59-64μ	61μ	28-35μ	31μ	10-18μ	13μ

The sub-epidermis is colourless except in the hilum region, where the sclerenchyma and star-cells have brown cell-contents—the column cells apparently lack pigment. When the column cells are seen in surface view (Fig. 4b, Pl. II) they present an appearance not unlike that met with in the Field Bean (*Vicia Faba*),† the wall of the dumb-bell shank

* Parkinson and Fielding, op. cit., p. 58 and Pl. X, Fig. 2 (*a*).
† Parkinson and Fielding, op. cit., Pl. X, Fig. 3 (b^1).

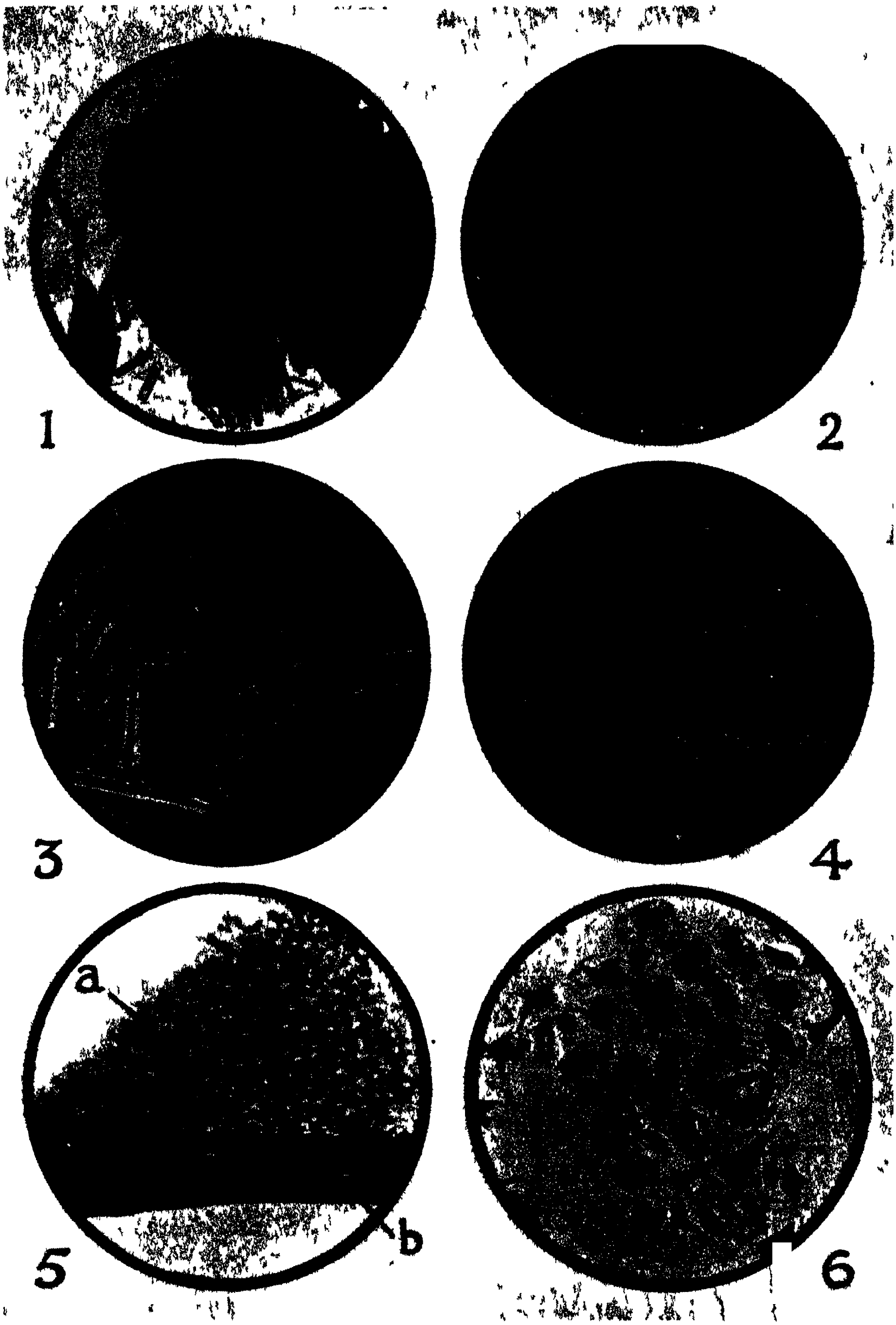

Fig 1—*C ensiformis* Fragments of Palisade × 24

Fig 3—*C ensiformis*. Isolated Palisade cells from body of seed × 145

Fig 5.—*C gladiata* (*a*) "Star-cells" from hilum region and (*b*) Parenchyma × 24

Fig 2—*C ensiformis* Palisade cells in surface vi × 145

Fig 4—*C ensiformis* (*a*) Isolated Palisade c from hilum region × 145 (*b*) Column cells surface view × 145

Fig 6—*C ensiformis* Isolated Sclerenchyma c from hilum region × 145.

appearing as a highly refractive circular outline surrounded by a polygonal wall representing the end of the cell. The gradual grading-off of the column cells into the parenchyma appears to be characteristic of *Canavalia* spp. Usually in leguminous seeds there is a sharp difference between these two tissues.

(*c*) The PARENCHYMA consists of thin-walled cells of no very great diagnostic importance (Figs. 1e, 2c, 5d, of Pl. I and Fig. 5b, Pl. II). The innermost layers of the parenchyma include the inner epidermis, and are so compressed in dried specimens that description is impossible (Figs. 2d, and 5e of Pl. I).

C.—THE EMBRYO.

(*a*) The COTYLEDONS.—The cotyledonary tissue is composed of large parenchymatous cells with beaded walls and circular inter-cellular spaces (well shown in Fig. 6a, Pl. I). The numerous starch-grains (seen clearly in Fig. 6b, and as black dots in Fig. 3, Pl. I) contained in the cell-cavities are typically leguminous in character, and not unlike those of *Phaseolus vulgaris*. They are ellipsoidal in shape, usually with a trifid central hilum, and average about 30μ in diameter.

SUMMARY OF POINTS OF DIAGNOSTIC IMPORTANCE

(1) Character and great length of palisade cells.

(2) Scattered thick-walled sclerenchyma and " star-cells " with brown contents in hilum region.

(3) The several layers of column cells and the transition from column cells to parenchyma.

(4) The " porous " cells of the cotyledon.

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THE INCORPORATION OF CONTACT INSECTICIDES WITH PROTECTIVE FUNGICIDES

POTATO FIELD TRIALS, 1930-1932

By M. D. Austin and H. Martin,
Research Department, South-Eastern Agricultural College, Wye.

In the routine spraying of fruit and hops there are occasions when the simultaneous application of contact insecticides, such as nicotine, rotenone or the pyrethrins, with protective fungicides, such as Bordeaux mixture or lime-sulphur, would be of obvious benefit. Examples of such occasions in the spraying of fruit are the pre- and post-blossom applications intended for the control of scab (*Venturia inaequalis* Aderh.) which coincide closely in time with those of the insecticidal washes necessary for the control of the capsid bug (*Plesiocoris rugicollis* Fall.). The simultaneous control of apple scab and of the apple fruit sawfly (*Hoplocampa testudinea* Klug.) might be possible by means of a calyx application of a combined insecticide-fungicide. On hops it may often happen that time and labour would be saved if it were possible to apply nicotine against hop aphis (*Phorodon humuli* Schrank.) at the same time as applying a copper-containing fungicide for the control of the downy mildew (*Pseudoperonospora humuli* (Miy. et Takah.) Wils.).

In the present spraying technique the protective fungicide is applied as a fine spray in quantities insufficient to produce a " drip " from the foliage whereas the contact insecticide wash is applied in large amounts sufficient to drench the foliage. A typical rate of application for Bordeaux mixture used for the spraying of hops is 300 gals. per acre whereas about 800 gals. of nicotine soap wash are applied per acre. A direct combination of nicotine with Bordeaux mixture is impossible for it is known that heavy application of Bordeaux mixture not only reduces fungicidal efficiency, but may make more liable Bordeaux injury, whereas light application of the nicotine wash is of inferior insecticidal efficiency. For the combined wash a new protective fungicide or a modification of Bordeaux mixture is required which can be applied in the same way as a nicotine soap wash.

For the derivation of protective fungicides which can be applied in this manner suitable methods are required for the examination of the fungicidal and phytocidal properties of the wash. Fruit trees are not suitable material for small-scale trials and the main object of the work to be described below has been the development of a technique using potato as the test plant and the potato blight (*Phytophthora infestans* (Mont.) de Bary.) as the fungus for the estimation of fungicidal efficiency. Although potatoes usually have a normal complement of injurious insects, their presence equally distributed and in sufficiently large numbers to warrant the laying out of suitable insecticidal trials is infrequent. As there is no insect pest of the potato suitable as a means of determining the insecticidal value of the combined insecticide-fungicide, observations were concerned mainly with the action of the insecticide on the deterioration of the potato. It is now generally accepted that the deterioration of potato stocks is the result of the accumulation of various types of virus disease and it is known that certain of the viruses

are carried from diseased to healthy plants by particular haustellate insect visitors. The investigations of Smith (1927) on the part played by certain of these insects, notably *Myzus persicae* Sulz., and those of Whitehead (1931) on *Myzus circumflexus* Buck., as vectors of certain virus diseases of the potato have established the fact that at least these two insects act as "carriers". The capsids (*Lygus pabulinus* Linn. and *Calocoris norvegicus* (*bipunctatus*) Gmel.) have not, however, been proved to be vectors of virus diseases (Smith, 1927). The potato leaf hoppers, although suspect, have likewise not been established as vectors. It has therefore been suggested (Smith, 1931) that the incorporation of an aphicide in the routine spray used for the protection of the potato against blight might be worth examination as a means of reducing the spread of virus infection. It was realized that, because of the migratory habits of the hemipterous pests, large areas suitably protected by guard rows would have to be sprayed if true indications of the results of the insecticide application are required. But in view of the greater importance of the fungicide trials and in order to obtain the full advantages of randomized replications, only in the first year's trials were the plots laid out on an ample scale and our object became to determine, whether or not, under the adverse conditions of the trials, the incorporation of nicotine or pyrethrum extract in the blight spray had any observable effect on the deterioration of the potato stock employed.

TRIALS IN 1930.

Early in 1930, the fungicidal action of vegetable oils on the hop powdery mildew (*Sphaerotheca humuli* (DC.) Burr.) was discovered by Martin and Salmon (1931) and information was required of the behaviour of the oils as substitutes for protective copper fungicides. If effective against copper-sensitive fungi, the vegetable oils would provide a valuable basis for the combined insecticide-fungicide for they have been used for the preparation of an insecticidal wash (Staniland, 1926). Experiments were therefore made of the action of vegetable oil-pyrethrum emulsions as substitutes for Bordeaux mixture in the control of potato blight.

A plot of King Edward potatoes, planted with " seed " direct from Scotland was placed at our disposal. The area, 56 rows of 20 yds. length, was divided at right angles to the direction of the rows into a north and south plot. The sprays were applied to each half of the plot in the following order, row 1 being on the west side of the plot:

		South half.	*North half.*
Rows	1-4	Cotton-seed oil (1%)	Sesame oil (2%)
	5-12	Rape-pyrethrum (a) (1%)	Sesame-pyrethrum (c) (1%)
	13-16	Cotton-seed (1%)	Sesame (2%)
	17-20	Sesame (1%)	Unsprayed
	21-24	Sesame-pyrethrum (a) (1%)	,,
	25-28	,, ,,	Rape (2%)
	29-32	Sesame (1%)	Rape-pyrethrum (c) (1%)
	33-36	Unsprayed	,, ,,
	37-40	,,	Rape (2%)
	41-44	Rape (1%)	Cotton-seed (2%)
	45-48	Sesame-pyrethrum (a) (1%)	Cotton-seed-pyrethrum (c) (1%)
	49-52	Cotton-seed-pyrethrum (b) (1%)	,, ,,
	53-56	Rape (1%)	Cotton-seed (2%)

Commercial grades of cotton-seed, rape and sesame oils were used throughout and the pyrethrum extract was prepared from the residue after evaporation of a light

petroleum extract of ground sun-dried pyrethrum flower heads. As the main crop of pyrethrum grown at Wye was not available in time for the preparation of all the required extract, various samples of flower heads from previous seasons were used for the first sprays. These samples are designated by index letters in the above table :—

(a)	prepared from flower heads containing	0·45%	pyrethrin I.
(b)	,, ,, ,, ,, ,,	0·53%	,,
(c)	,, ,, ,, ,, ,,	0·36%	,,
(d)	,, ,, ,, ,, ,,	0·49%	,,

Sample (d), from the main crop of pyrethrum, was used for the preparation of all sprays required for the second application. The residue after evaporation of the light petroleum was dissolved in the required vegetable oil in amounts sufficient to give a final spray concentration equivalent to 1 per cent flower heads. Emulsification of the oil or oil-pyrethrum solution was accomplished by the use of Agral W.B., the ratio of oil to Agral used being 9 to 1 by volume. The required amount of oil-Agral mixture was added to water containing sodium hydroxide at the rate of 1·5 ml. 20 per cent NaOH per 1 ml. Agral W.B. and the emulsion so produced was diluted with water to give an oil concentration of 1 or 2 per cent as required.

The first application was made by means of a knapsack sprayer to the south half of the plot on 7 July 1930 and to the north half of the plot on 10 July 1930. The sprays were applied in the manner usual for contact insecticides so that the maximum amount of foliage of the plants was wetted. Spray drift from one row to another was avoided as far as was possible. Any weeds present in the treated rows were also sprayed as it has been established (Smith, 1930) that certain weeds may be " hosts " of potato viruses and hence a potential source of infection to the potatoes. Previous to spraying the plot was inspected and no blight infection was observed. One plant showing symptoms suspected to be of " streak " was rogued. The incidence of insect pests on the plot was not abnormal: local infestations of *Myzus pseudosolani* Theo., occurred and the capsid, *Calocoris norvegicus* Gmel. was frequently observed on portions of the plot near the hedge, some plants being heavily attacked by this bug. *Lygus pratensis* Linn. and *L. pabulinus* Linn. were less commonly seen. The occurrence of these pests was more noticeable during the latter part of the summer. It was observed that the insecticide-containing sprays successfully kept in check the Aphid concerned, but the control of the capsids was less successful, possibly because of their ability to move rapidly. On 10 July when the north part of the plot was sprayed, several leaves were found infected with blight. The second application of the sprays was made on 26 July 1930 when numerous blight infections were seen.

On later visits to the plot no difference between the development of blight on the unsprayed and sprayed parts of the plot could be seen and, by the end of August, the entire plot was defoliated by the disease. It was evident that the sprays had exercised no protective fungicidal action and no observations were therefore made of the weight of tubers lifted. For the determination of the effect of the sprays on the spread of virus disease, the whole crop from one row, selected at random from the middle rows of the plots concerned, of the potatoes sprayed with the cotton-seed oil-pyrethrum and sesame oil-pyrethrum sprays and from the unsprayed plot, was saved. These potatoes were stored and used as " seed " the following year, a watch being kept for aphis during the shooting of the tubers. As no aphis were observed, treatment of the " seed " with insecticide was unnecessary.

1931 TRIALS.

The failure of the vegetable oil sprays to control blight made necessary a search for some form of copper-containing spray suitable for application in large quantities. At the same time an endeavour was made to retain the vegetable oils because of their value as direct fungicides against the Erysiphaceae and as " carriers " of contact insecticides. Two possibilities were therefore examined ; firstly, the use of vegetable oils emulsified with Bordeaux mixture when it has to be shown that the protective fungicidal properties of the deposit left on the foliage by the Bordeaux mixture are not adversely affected by the vegetable oil present ; secondly, the use of an oil solution of a suitable copper compound such as a copper soap, in which case the efficiency of copper applied in this form as a protective fungicide has to be established. A third possibility investigated was the use of a spreader with Bordeaux mixture when it has to be shown that the presence of the spreader permits the application of Bordeaux mixture in large quantities without adversely affecting the fungicidal and phytocidal properties of the spray. As one theory of the action of Bordeaux mixture suggests that the active fungicide is the copper ion which kills by combination with the proteins of the organism, the use of a protein spreader such as casein or gelatine might cause a reduction of fungicidal efficiency. The use of a non-protein spreader such as sulphite lye (Martin, 1932) avoids this possibility. Preliminary trials showed that not only may the Bordeaux-sulphite lye spray be applied after the manner of a contact insecticide without marked phytocidal action, but solutions of sulphite lye cause the rapid disintegration of the zoospores of *Pseudoperonospora humuli* after the manner of soap solutions (Goodwin, Salmon and Ware, 1929). Lastly a trial was made of salicylanilide, a new fungicide found at the Shirley Institute (Fargher, Galloway and Probert, 1930) to be effective in the protection of cotton fabric from mould fungi.

The area available for the trials was divided into a four treatment Latin square, each sub-division being of five rows about 20 ft. long. A triangular area was used for the testing of those sprays not included in the treatments used in the Latin square. The latter four treatments were : (1) Unsprayed ; (2) ordinary Bordeaux mixture ; (3) Bordeaux mixture and sulphite lye, using nicotine as the contact insecticide and, (4) cotton-seed oil solution of pyrethrum extract emulsified with Bordeaux mixture. The arrangement of the treatments having been chosen at random the " seed " saved from the 1930 trials was planted so that each sample occupied four rows of one of the sub-divisions of the plot. Seed from the plot unsprayed in 1930 was again not sprayed ; that which was lifted from potatoes sprayed with the sesame oil-pyrethrum combination in 1930 was sprayed with cotton-seed oil-pyrethrum-Bordeaux emulsion in 1931 ; that treated with the cotton-seed oil-pyrethrum spray in 1930 was now sprayed with the nicotine-Bordeaux-sulphite lye wash.

The Bordeaux mixture used was prepared by the addition of a 10 per cent copper sulphate ($CuSO_4$, $5H_2O$) solution to water containing hydrated lime in the proportions of 10 lb. copper sulphate, 15 lb. hydrated lime, 100 gals. of water. For the Bordeaux-sulphite lye-nicotine spray the same proportions of copper sulphate, lime and water were used and concentrated sulphite lye of 60° Tw. (Sp. Gr. 1·30), at the rate of 0·75 gal. per 100 gals. of spray, was added to the water prior to the addition of the copper sulphate solution. Just before application, nicotine (95-98 per cent) was added to the spray at the rate of 3·2 oz. per 100 gals. The pyrethrum extract was obtained from the 1930 crop of flower heads (0·49 per cent pyrethrin I), the resin obtained by the distillation of a light petroleum extract being dissolved in a commercial edible grade of cotton-seed oil. For the preparation of the emulsion the required amount of this

solution was added to the copper sulphate solution and the mixture poured into the milk of lime suspension. The oil emulsified readily on vigorous stirring of the mixture which contained 1 per cent flower heads, 1 per cent cotton-seed oil and 10 : 15 : 100 Bordeaux mixture. The spray was applied as soon as possible after preparation.

After a preliminary examination of the solubility of various copper soaps in cotton-seed oil, a sample of copper oleate containing 7·8 per cent copper and 76 per cent fatty acids was chosen for the preparation of the oil-soluble copper spray. For the emulsification of this solution the two-solution oleic acid method (Martin, 1931) was employed and a solution containing ten parts by volume cotton-seed oil, 1·5 parts by volume oleic acid (a brown commercial grade) and 1 part by weight of copper oleate was prepared. This solution was then added to water containing 1 part by weight of sodium hydroxide for every 3 parts by volume of oleic acid used and the resultant emulsion was diluted to a content of 2 per cent cotton-seed oil and 0·2 per cent copper oleate.

For the salicylanilide sprays samples of "Shirlan Paste," kindly supplied by the Imperial Chemical Industries, Ltd., were used. The paste was diluted with a 0·25 per cent solution of Agral 1 so as to give a final concentration of 1 per cent salicylanilide. For the third application, however, Shirlan Paste was not available and a suspension of salicylanilide was prepared by the addition of an alcoholic solution of Shirlan powder to the Agral 1 solution, the final concentration of the spray being 1 per cent by weight salicylanilide, 15 per cent by volume methylated spirit and 0·25 per cent by weight Agral 1.

The first application of the sprays was made by means of a knapsack sprayer on 15 July and, although blight infections were not seen before 6 August a second spraying was carried out on 31 July. On both occasions weather conditions were perfect from the spraying point of view but heavy rains followed during the first fortnight of August. Subsequent to this rain the plants made so much new growth that a third application of the sprays was considered necessary and carried out on 18 August.

Local infestations of *Myzus persicae* Sulz. were noted at the end of July, and *M. pseudosolani* Theo. was also present but at no time did these aphides become at all prevalent on the plot as a whole. Nymphs of the second generation of *Lygus pabulinus* occasionally occurred, and adult and immature forms of *Calocoris norvegicus* were observed in some numbers, both insects being more common on portions of the plot near the hedge. The general effect of the insecticidal sprays was as noted for the 1930 trials.

On 6 August the rows planted with "seed" saved from the 1930 trials were examined and a count made of the plants showing abnormal habits of growth symptomatic of virus infection. On the unsprayed plot fourteen such plants were found out of a total of 123 plants whereas on the sprayed plots only one plant was found, the habit of growth of which suggested virus infection.

By the end of the month blight had caused the complete defoliation of all plants in the unsprayed plots and on all the sprayed plots of the Latin square the haulm was green and fairly free from blight. The rows outside the Latin square which had been sprayed with the copper oleate-cotton-seed oil spray and with the salicylanilide-Agral 1 wash were badly infected and it was impossible to detect any difference in the amount of blight on these rows and on the adjacent unsprayed rows. The observations indicated that whereas the modifications of Bordeaux mixture examined, namely, cotton-seed oil-Bordeaux mixture and Bordeaux-sulphite lye, were effective in controlling blight, the copper oleate-cotton-seed oil and the salicylanilide sprays were ineffective.

The crop was lifted during the week beginning 13 October and the total weight of tubers per row determined. As much dirt as possible was removed from the potatoes by hand rubbing before weighing and all tubers infected with blight were weighed separately and discarded ; the weight of diseased tubers showed no noteworthy differences from an average of about 2 lb. per row. The whole crop from " seed " saved from the 1930 trials was weighed and stored apart. Diagram 1 below gives the arrangement of the treatments and the average weight (in lb.) per row per plot, the figures for the 1930 " seed " being omitted.

DIAGRAM I.

	Copper oleate-cotton-seed oil 30·5	Unsprayed 30·5	Salicylanilide 36·5
Bordeaux mixture 43	Unsprayed 36	Cotton-seed oil-Bordeaux 47	Bordeaux-sulphite lye 59
Unsprayed 31	Bordeaux-sulphite lye 40	Bordeaux mixture 45	Cotton-seed oil-Bordeaux 74
Cotton-seed oil-Bordeaux 41	Bordeaux mixture 53	Bordeaux-sulphite lye 58	Unsprayed 43
Bordeaux-sulphite lye 27	Cotton-seed oil-Bordeaux 36	Unsprayed 28	Bordeaux mixture 39

The average yield per row for each treatment is therefore :—

Unsprayed	34·5 lb.
Bordeaux mixture	45·0 lb.
Bordeaux-sulphite lye	46·0 lb.
Cotton-seed oil-Bordeaux	49·5 lb.

and the analysis of variance gives the following :—

Variance due to	Degrees of freedom.	Sum of squares of deviations.	Variance σ^2	$\frac{1}{2}\log_e \sigma^2$
Rows	3	687·5	—	—
Columns	3	699·5	—	—
Treatments	3	501·0	167·0	2·55899
Error	6	417·0	69·5	2·12069
				" z "=0·43830

As " z " does not exceed 0·78, the value appropriate for P=0·05, the difference in yield due to treatment is not significant. Nor does the omission of yields from the lower row of plots, which were on wetter and colder ground, give a significant difference due to treatment.

The average yield per row of the " seed " saved from the 1930 trials was as follows :—

Unsprayed	38·0 lb.
Pyrethrum sprays	73·75 lb.
Pyrethrum-nicotine	64·5 lb.

but the probability that these differences have arisen by chance or by treatment cannot be determined. These tubers were saved for use as "seed" in the 1932 trials. On storage a few developed blight but no aphis was found on the sprouting tubers.

1932 TRIALS.

The area available for these trials was divided into a five treatment Latin square, each sub-division being of six rows about 26 ft. long. The whole plot was planted with "seed" saved from the 1931 trials and, for convenience, the three lots were numbered I, II and III; I indicating seed from plots treated with the sesame oil-pyrethrum emulsion in 1930 and with the Bordeaux-sulphite lye-nicotine spray in 1931; II indicating seed from plots unsprayed in the two previous years, and III being seed from plots sprayed with cotton-seed oil-pyrethrum emulsion in 1930 and with the Bordeaux-cotton-seed oil-pyrethrum spray in 1931. Two adjacent rows of each sub-plot were planted with either I, II or III seed, the actual position being chosen at random.

The sprays employed were similar to those used in the 1931 trials, namely, 10:15:100 Bordeaux mixture plus 0·75 per cent sulphite lye (60° Tw.) plus 0·02 per cent nicotine, and two modifications of the vegetable oil Bordeaux emulsion. In one of these modifications half strength Bordeaux mixture (i.e. 5 : 7·5 : 100) was used to emulsify cotton-seed oil at the rate of 0·75 per cent by volume, 0·02 per cent nicotine being added as the insecticide. In the second modification, full strength Bordeaux mixture was used to emulsify a cotton-seed oil solution of pyrethrum extract, the final spray containing 0·75 per cent cotton-seed oil and 0·002 per cent pyrethrins. This reduction of the concentration of pyrethrins was adopted because evidence had been found in other trials (Austin, Jary and Martin, 1932) that a concentration of 1 per cent flower heads is unnecessarily high for flower heads of a content of approximately 1·5 per cent total pyrethrins.

The first application of the sprays was made on 18 July and was followed by heavy rain. Although the spray had dried on the foliage before rain fell it was evident that, on many of the plots, much of the copper deposit had been washed off. As no blight infection was seen until 8 August, the second application was delayed until 11 August. Weather conditions were apparently unfavourable for the spread of the disease and defoliation of the unsprayed haulm proceeded slowly. It was evident, however, that all the sprays were of similar protective fungicidal abilities and the haulm on the sprayed plots did not die down until three to four weeks later than that in the unsprayed plots.

No heavy infestations of aphides or capsids were observed; towards the end of the summer localized attacks of *Calocoris norvegicus* occurred. Aphides were present in approximately similar numbers to the two previous years. Leaf hoppers (*Typhlocyba* spp.) were abundant in certain areas of the plot, notably on the unsprayed portions.

Counts were made to determine the distribution of plants showing symptoms of virus infection. About 16 per cent of the total plants showed abnormal habit of growth and as the distribution was independent of the type of "seed" used in the row, it was not considered worth while to continue, with tubers saved from the plot, the investigation of the effect of the incorporation of an insecticide with the blight spray on the spread of deterioration.

The crop was lifted on 15-18 October and the weight taken, in each two rows, of ware and total tubers. The figures for seed and chat potatoes and for blighted tubers showed no noteworthy differences and in the diagram II, which also shows the distribution of treatments and "seed," the total weight (in lb.) of healthy tubers is recorded.

DIAGRAM II.

Unsprayed			Oil-Bordeaux (0·75:5:7·5:100)			Bordeaux (10:15:100)			Bordeaux (10:15:100) -sulphite lye			Oil-Bordeaux (0·75:10:15:100)		
II	I	III	I	III	II	I	II	III	II	I	III	III	I	II
34	47·5	49	52	47·5	44·5	52	49	55	42	57	44	52	45	40
Bordeaux (10:15:100) -sulphite lye			Unsprayed			Oil-Bordeaux (0·75:10:15:100)			Oil-Bordeaux (0·75:5:7·5:100)			Bordeaux (10:15:100)		
II	I	III	II	III	I	III	II	I	III	I	II	I	III	II
49	66	42·5	38	46	56	43	35·5	53	50	50	40	43	60	51
Oil-Bordeaux (0·75:5:7·5:100)			Oil-Bordeaux (0·75:10:15:100)			Unsprayed			Bordeaux (10:15:100)			Bordeaux (10:15:100) -sulphite lye		
II	III	I	I	III	II	III	I	II	II	I	III	I	III	II
45	50	42	49	52	39	49	54	39	49	39	52	49	49	54
Bordeaux (10:15:100)			Bordeaux (10:15:100) -sulphite lye			Oil-Bordeaux (0·75:5:7·5:100)			Oil-Bordeaux (0·75:10:15:100)			Unsprayed		
III	I	II	II	I	III	I	II	III	III	II	I	III	I	II
57	54	40	44	74	52	40	44	59	69	45	48	48	49	53
Oil-Bordeaux (0·75:10:15:100)			Bordeaux (10:15:100)			Bordeaux (10:15:100) -sulphite lye			Unsprayed			Oil-Bordeaux (0·75:5:7·5:100)		
I	II	III	I	III	II	II	III	I	III	I	II	II	I	III
58	47	37	52	57·5	47	39	42	48	33	45	53	56	48	57

For ease of reference the full strength Bordeaux mixture (10:15:100) containing 0·75 cotton-seed oil is described as Oil-Bordeaux (0·75:10:15:100) and the half strength Bordeaux mixture (5:7·5:100) as Oil-Bordeaux (0·75:5:7·5:100).

The average yield of healthy tubers per two rows is therefore :—

Unsprayed	46·2 lb.
Bordeaux mixture (10:15:100)	50·3 lb.
Bordeaux (10:15:100)-sulphite lye	50·1 lb.
Oil-Bordeaux (0·75:10:15:100)	47·5 lb.
Oil-Bordeaux (0·75:5:7·5:100)	48·3 lb.

and the analysis of variance shows no significant difference due to the sprays :—

Variance due to	Degrees of freedom.	Sum of squares of deviations.	Variance σ^2	$\frac{1}{2}\log_e\sigma^2$
Treatments	4	191·0	47·75	—
Blocks	4	200·0	50·00	—
Columns	4	142·0	38·00	—
Error (*a*)	12	421·0	35·08	—
" Seed "	2	563·6	281·80	2·82057
Error (*b*)	48	2770·4	57·72	2·02790
				" z "=0·79267

The failure to obtain significant differences due to treatment in both the 1931 and 1932 trials suggests that the determination of yield of healthy tubers may not be

a suitable method for the estimation of fungicidal efficiency. In both years, however, the observations of the appearance of the disease in the potato haulm has given greater indications of differences in fungicidal efficiency and it is possible that, on this basis, a suitable technique for the field comparison of protective fungicides may be evolved.

On the other hand, differences due to previous treatment of the " seed " are significant, for "z" exceeds 0·56, the value appropriate for P=0·05. Calculation of the average weight of healthy tubers for the two row sub-divisions of the small plots and of the significant difference give the following :—

" Seed "	I Pyrethrum (1930) Nicotine (1931)	..	50·82 lb.
,,	II Unsprayed (1930 and 1931) ..	..	44·68 lb.
,,	III Pyrethrum (1930) pyrethrum (1931)	..	50·10 lb.

Significant difference 4·30 lb.

There is therefore no difference between the yields from seed saved from plants sprayed with the insecticide-fungicide combinations, but these treatments have given a significant increase over seed saved from plants unsprayed in the two previous years.

Summary.

1. An account is given of field trials of various combinations of contact insecticides and protective fungicides for the control of potato deterioration and potato blight.

2. The following washes were found ineffective in controlling potato blight :—

(*a*) Cotton-seed, rape or sesame oil solutions of pyrethrum extract, emulsified at 1 per cent by means of Agral W.B., and 2 per cent emulsions of the same oils.

(*b*) Copper oleate, at 0·2 per cent, in solution in cotton-seed oil emulsified at 2 per cent by the two-solution oleic acid method.

(*c*) Salicylanilide, at 1 per cent, in suspension in 0·25 per cent Agral 1.

3. The following modifications of Bordeaux mixture were as effective as 10 : 15 : 100 Bordeaux mixture in controlling potato blight :—

(*a*) 10 : 15 : 100 Bordeaux mixture with 0·75 per cent concentrated sulphite lye (60° Tw.) and 0·02 per cent nicotine.

(*b*) 1 per cent and 0·75 per cent cotton-seed oil (containing pyrethrum extract) emulsified with 10 : 15 : 100 Bordeaux mixture ; 0·75 per cent cotton-seed oil (containing 0·02 per cent nicotine) emulsified with 5 : 7·5 : 100 Bordeaux mixture.

4. The application of the modified Bordeaux mixtures after the manner of a contact insecticide wash did not result in injury to the potato foliage.

5. Estimations of the degree of blight control on the basis of yield of healthy tubers were found unsuitable for the detection of small differences in fungicidal efficiency.

6. The yield of tubers from " seed " saved from potatoes washed in the two previous seasons with a contact insecticide was significantly greater than that of " seed " from potatoes unsprayed in the two previous seasons.

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INVESTIGATIONS ON THE INSECT AND ALLIED PESTS OF CULTIVATED MUSHROOMS

I. *SCIARA FENESTRALIS* ZETT.

By M. D. Austin and S. G. Jary,

Entomological Department, South-Eastern Agricultural College, Wye.

Of a number of insects which attack cultivated mushrooms, certain flies of the genus Sciara are probably the most common and destructive. It would appear that several species may be responsible for Symes (1921) records *Sciara praecox* Meig , Theobald (1927, 1928, and 1929) mentions *S. agraria* Felt. and *S. annulata* Meig., while Speyer (1927) has noted *S. auripila* Winn All these records refer to serious damage caused by the larval stages of the flies, in this country. Thomas (1931) considers fly pests to be the most injurious insects attacking mushrooms in U.S.A., Stapel (1932) records attacks in Denmark and similar observations have been made in France and Germany. During the past year, attacks by *Sciara* spp. have been identified by the writers on mushrooms received from Cambridgeshire, Herefordshire, Gloucestershire, Kent, Lincolnshire, Surrey and Sussex and also Scotland. In the course of our investigation upon insects attacking mushrooms, *Sciara fenestralis* Zett has commonly occurred and as this species does not seem to have been recorded hitherto on this crop, the life-history is here briefly described The other species which have been bred from infested mushrooms have already been recorded elsewhere by Austin (1933).

On 7 October 1932, a quantity of badly damaged mushrooms was received, in which Sciarid larvae were plentiful. Numerous eggs were also found, occasionally deposited singly, but more usually in strings of from four to nine, which were plainly visible to the naked eye in good light. The eggs were isolated, placed on the soil near growing mushrooms and covered with an insect-proof cage, after which the cage was placed in an outdoor insectary. In three to four days hatching took place and typical Sciarid larvae were produced. These burrowed at once into the compost and were found to enter the stalks of the mushrooms at their bases, just below ground level. Characteristic larval tunnels were made in the stalks and within fifteen days some larvae had penetrated as far as the caps, the general progress of the attack closely resembling that commonly found in commercial mushroom beds. There was no outward indication of the presence of the larvae. They continued to feed for a period of fifteen to twenty days after hatching and when fully grown pupated in the soil. Prior to pupation a period of two to three days was occupied by the larvae in constructing a cocoon of soil particles and silken threads, the latter produced by the larvae themselves. Inside this cocoon the pupa was formed, but some of the larvae pupated without making a cocoon. The first flies emerged on 5 November 1932 and other individuals continued to emerge until 11 November. These were identified by Dr. F. W. Edwards as *Sciara fenestralis* Zett.

The *ova* which are blunt oval in shape, translucent and of whitish colour, measured approximately 0·70 mm. by 0·32 mm. and hatched within a period of three to four days.

The duration of this stage may normally be somewhat longer, since the eggs in question had possibly been laid a few days before they were received and subsequent observation showed that seven days is a more usual period.

The *larvae* are white, cylindrical, with a black well developed head-capsule and the alimentary tract, when containing food, usually shows clearly. On hatching they measured 0·85 to 0·90 mm. and at maturity attained a maximum length of 10 mm. The body is composed of twelve segments, in addition to the head. The fully grown larvae spend two to three days in constructing a cocoon in which to pupate.

Fig. 1.—Larva *Sciara fenestralis* Zett. × 15.

The *pupae*, formed usually within a cocoon, gave rise to flies in from eight to fourteen days.

The duration of the life-history may therefore be summarized :—

Eggs four to seven days.
Larvae fifteen to twenty days.
Preparation of cocoon two to three days.
Pupae eight to fourteen days.

The *imago :* the adult male fly has a body length of about 2 mm. but in the female the average size is larger, varying with the condition of eggs in the abdomen. The head and thorax are black and the abdomen of a deep smoky brown colour, rather darker toward the apex, which in the female is pointed and in the male terminates in the claspers. The abdomen is covered with a fine, short, dark pubescence. The antennae, of fifteen segments, are entirely dark and covered with short dark hairs ; the basal joint is swollen and the remaining joints are two and a half to three times as long as broad. The legs are about one and a half times as long as the body, of a light brownish yellow colour, the anterior pair being rather lighter than the others. A small dark area is present at the junction of the femora and trochanters. Sparse, dark hairs are present on the femora and more thickly set on the tibiae and tarsi. The tarsi are somewhat darker than the remaining joints and terminate in two small claws. Two prominent spines occur on the inner side of the apex of the tibiae.

The wings of the adult flies, on emergence from the pupae, were vestigial and were not normally expanded for a few hours. Copulation usually took place on the day of emergence and oviposition commenced two to three days afterwards, the average number of eggs laid by an individual being twenty-five to thirty. They were normally placed on the surface of soil or manure, but occasionally on the mushrooms and in a few cases on the caps.

The accurate identification of the species of this genus is a matter of some difficulty and necessitates dissection of the male genitalia. For details and help in this matter we are indebted to Dr. F. W. Edwards who has given us great assistance and has explained the technique used by himself. Fig. 2 shows the external portion of the male genitalia of *S. fenestralis* Zett. and for the purpose of this paper it is sufficient to mention that the presence of a small projection, bearing from four to eight hairs at the base of the hypopygium on the ventral side, is an important feature.

OTHER OBSERVATIONS.

Since it appears that these flies may pass through a complete generation in approximately one month, it would seem that two, three or even four generations may occur while a mushroom bed is normally cropping, so that a series of attacks may occur and as the generations begin to overlap, conditions of continuous infestations may arise. It is common to see numbers of flies running rapidly over the surface of beds, and they do not readily take to the wing, but make short, jumping flights, a point which is important in relation to control measures. Quite frequently a number of mites, particularly immature stages, are found attached to the bodies of the flies. Since various species of mites commonly attack mushrooms, there is the further possibility to be considered, namely the spread of mites by flies, in this manner.

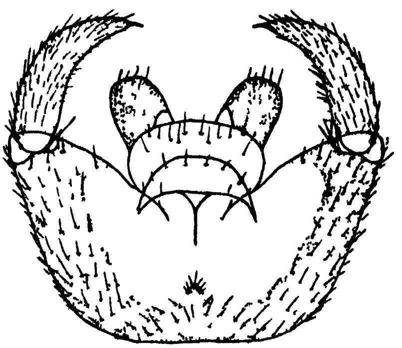

Fig 2.—♂ Genitalia of *Sciara fenestralis* Zett Ventral aspect × 73

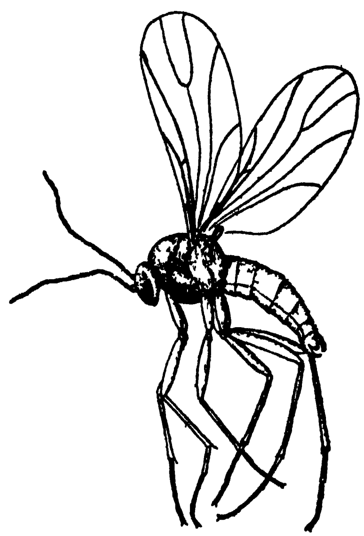

Fig 3.—*Sciara fenestralis* ♂ × 13

The typical damage caused by larvae feeding within the stalks and caps of mushrooms takes the form of extensive tunnelling and it is this condition which most commonly attracts the growers' attention. It has been observed that after picking and transport to market, the mushrooms have become covered with larvae and some proportion becomes unsaleable. There is reason to believe, however, that another and more insidious form of damage occurs, involving direct injury to the running spawn. Larvae have been observed feeding on the mycelium and in so doing must prevent the formation of buttons. Moreover, cases are frequently seen in which small buttons appear through the casing soil and then become brown and leathery, failing to develop further, but apparently not actually attacked themselves. Such a condition can probably be caused by larvae severing the threads of mycelium from which the mushroom is growing.

The gregarious habit of Sciarid larvae under certain conditions has been referred to by other writers and this phenomenon has been observed. It appears to occur under somewhat dry conditions and it is suggested that the larvae may congregate in this fashion in order to minimize the effects of dessication. They thrive best under moist conditions.

Control Measures. Attempts to reduce fly infestations in mushroom houses have been made by many growers, who aim at achieving the result in different ways. Fly papers covered with some adhesive substance are frequently placed in the houses, either laid on the beds or suspended near windows. Numbers of flies may be caught in this way but the method can only be regarded as supplementary to other forms of control. Where houses admit of fumigation, the volatilization of nicotine sometimes gives good results and appears not to harm the crop. Conditions in mushroom houses, however, seldom favour fumigation and results in such buildings are likely to be disappointing. On the whole, greater success has attended the use of nicotine sprays and concentrations of 10 oz. or more of nicotine (95 to 98 per cent purity) in 100 gals. of water have been employed. The spray is applied when the flies are first seen on the beds and repetitions are made every few days as necessary. Applications can be made by means of a fine rose on a watering can, when they take the place of the usual watering periodically given to the beds. The adult flies are killed and no damage is done to the crop, provided that soap is not used in the liquid. There is evidence that soap solution has a harmful effect on the growth of mushrooms. It is not suggested that the use of nicotine will result in immediate freedom from fly attacks already in progress, but since adults and young larvae, either hatching or just in the soil, are killed, regular applications will prevent infestations from reaching serious proportions.

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STUDIES ON THE OVICIDAL ACTION OF WINTER WASHES, 1932 TRIALS

By M. D. Austin, S. G. Jary and H. Martin,

Research Department, South-Eastern Agricultural College, Wye, Kent.

The investigation of the ovicidal properties of tar, petroleum and vegetable oils, of which a progress report was published in last year's *Journal* (Austin, Jary and Martin, 1932), has been continued. Experiments carried out during the 1932 season may be conveniently described under (1) Laboratory Trials, and (2) Field Trials.

1. Laboratory Trials.

The main conclusion derived from the results of tests carried out in 1931 was that, of washes prepared from representative tar, petroleum and vegetable oils by the two-solution oleic acid method, the greatest ovicidal efficiency against eggs of the common green capsid bug (*Lygus pabulinus* Linn.) is shown by those containing petroleum oils. This conclusion is supported by the evidence of trials reported below and further work has been carried out to determine with what particular properties of the oils ovicidal efficiency can be correlated. For this purpose, the ovicidal action of petroleum oils of different physical and chemical characteristics was compared. Preliminary tests have also been made of the influence of the addition of tar oils, and of the type of emulsification, on the efficiency of the oils as ovicides.

As in the previous year, the laboratory trials were carried out on the eggs of *L. pabulinus* laid in the wood of red currants under natural conditions in the field. All the twigs were obtained from a small block of bushes of the variety Fay's Prolific. The cuttings were taken in early winter, tied in bundles and bedded in sand out of doors. When the treatments were carried out, twenty twigs per treatment, taken at random, were immersed in the wash contained in a glass cylinder, after which they were laid out to dry. When dry, the twigs were inserted in pots of damp sand, five in a pot, and the pots embedded in a cinder bed out of doors. They remained there throughout the winter and early spring, until a short time before egg hatching began when they were taken into a small unheated greenhouse and arranged on the staging in such a way as to facilitate subsequent examination, where they remained until hatching was completed, receiving liberal watering as necessary. Under these conditions, the growth of the twigs proceeded normally and their appearance is shown in Fig. 1, a photograph taken on 5 May. When hatching was complete, the bark was peeled from the twigs and an examination made for hatched and unhatched eggs. The hatched eggs show as clear white shells without much discoloration whereas the dead eggs are darkened and frequently distorted. The twigs were examined daily during the hatching period and the young capsids removed as they appeared. In order to prevent, before they were removed, any migration of the insects from one pot to another, the edges of the pots were covered with a grease-banding composition. Subsequently, the number of hatched eggs found on peeling the twigs was found to correspond exactly to the number of capsids removed from the twigs. The

treatment of the twigs was carried out on 18 February, the pots were transferred to the greenhouse on 19 April and the hatching period extended from 5 May to 7 June.

In all the laboratory trials, except those described under section (*e*), the washes were prepared by the two-solution oleic acid method of emulsification (Martin, 1931b), the final wash containing 0·6 per cent oleic acid and 0·1 per cent sodium hydroxide in addition to the oil.

Fig 1 —Red Currant Cuttings showing their development at the time of hatching of eggs of *Lygus pabulinus* (Linn)

(*a*) *Glyceride oils versus Hydrocarbon oils as ovicides.*

This trial is a repetition of that carried out in 1931, using washes prepared from representative tar, petroleum and vegetable oils Of the three samples of tar oil used, one (T2) conformed to the Long Ashton specification (Staniland, Tutin and Walton, 1930), the second (T3) was a strained anthracene oil which had been refrigerated to ensure a more complete removal of anthracene and the third (T4) was an anthracene oil from which the anthracene was removed by filtration through glass wool immediately prior to the preparation of the wash The water-white petroleum oil (L2) and the semi-refined petroleum oil (P2) approximated closely in characteristics to the oils used in the 1931 trials Crude cotton-seed and crude expressed oil of mustard were again employed as the vegetable oils and the addition of oleic acid was unnecessary for the emulsification of these two oils. All the washes contained 6 per cent of oil and the characteristics of the tar and petroleum oils, determined by the methods previously described (Martin, 1931a and Austin, Jary and Martin, 1932) are given in Table 1.

TABLE 1.

Percentage by weight.	Tar oils. T2.	T3.	T4.	Petroleum oils. L2.	P2.
Neutral	91·9	83·8	88·5	100	100
Acids	0·8	4·5	3·8	—	—
Bases	7·2	6·8	7·1	—	—
Sp. Gr. (60° F.)	1·105	1·105	1·112	0·866	0·898
Viscosity, Redwood 1 @ 70° F.	88″	101″	142″	127″	166″
Boiling Range:					
1st drop	250	(Water)	(Water)	240	334° C.
10% by vol.	287	275	291	320	346
20%	305	293	308	330	355
30%	312	308	318	335	363
40%	—	323	330	345	369
50%	334	333	339	354	377
60%	346	344	350	360	—
70%	356	354	359	370	—
80%	366	365	370	390	—
Iodine value (Wijs)	—	—	—	0·5	10·0
Unsulphonated residue, % by vol.	—	—	—	97·9	64·7

The ovicidal action of these washes is shown in Table 2, which gives the counts of hatched and unhatched eggs for each treatment.

TABLE 2.

	Eggs hatched.	Eggs unhatched.	Total eggs.
Tar oils:			
T2	13	13	26
T3	25	0	25
T4	10	17	27
Petroleum oils:			
L2	0	34	34
P2	0	30	30
Vegetable oils:			
Cotton-seed	0	25	25
Oil of mustard	1	27	28

The results are in agreement with those obtained in 1931 and indicate the greater ovicidal efficiency of the petroleum oils as compared with tar oils at the same concentration. The vegetable oils appear to be only slightly inferior to the petroleum oils and there are noteworthy differences in the ovicidal action of the three tar oils used.

(*b*) *Petroleum oils of different characteristics as ovicides.*

The purpose of these trials was to ascertain to what extent the ovicidal efficiency of various petroleum oils could be correlated with their characteristics. As has been explained in last year's report, the characteristics taken into account have been those which appear to determine the permanence of the oil film to which, it is generally held,

the toxic action is due. These characteristics fall into two groups, firstly, the physical constants of boiling range and viscosity, secondly, the chemical properties expressed by iodine value and unsulphonated residue. Oils, all of asphaltic base, were selected in pairs of which one oil differed from the other in one characteristic, but was approximately similar in the remaining properties. Because of the interdependence of viscosity and boiling range and of the relationship between iodine value and unsulphonated residue, the extent and type of the differences examined is limited. The characteristics of the oils tested are shown in Table 3.

TABLE 3.

	L3	L4	L5	P3	P4	L6	P5
Sp. Gr. (60° F.)	0·864	0·885	0·864	0·875	0·898	0·885	0·938
Viscosity, Redwood 1 @ 70° F.	126″	357″	136″	157″	160″	800″	4500″
Boiling Range:							
1st drop	310	325	312	308	335	—	316° C.
10% by vol.	321	355	325	326	346	384	392
20%	333	365	334	336	353	394	398
30%	343	375	343	345	360	—	—
40%	351	383	352	353	367	—	—
50%	359	390	361	362	375	—	—
60%	368	398	371	373	383	—	—
70%	376	—	381	385	391	—	—
80%	386	—	391	398	—	—	—
Iodine value (Wijs)	0·4	0·5	0·6	5·0	5·0	0·0	16
Unsulphonated residue, % by vol.	96·4	96·7	96·1	81·8	64·6	100	App. 80*

* Oil layer imperfectly separated from acid layer.

Tests were made with oil concentrations of 5 and 3 per cent and the results of counts of hatched and unhatched eggs are given in Table 4, in which the results are grouped in pairs according to the characteristics which it is desired to compare.

TABLE 4.

	At 5 per cent.			At 3 per cent.		
	Hatched.	Unhatched.	χ^2	Hatched.	Unhatched.	χ^2
(1) Oils of different viscosity or boiling range but of similar iodine value or unsulphonated residue:						
L3	0	26	—	0	33	15·1
L4	0	26		11	17	
P3	0	36	—	0	29	8·6
P4	0	28		7	20	
(2) Oils of similar viscosity or boiling range but of different iodine value or unsulphonated residue:						
L5	0	40	—	0	31	—
P3	0	36		0	29	
L2	3	31	2·2	4	23	0·26
P2	0	24		3	26	
L6	0	38	—	2	30	6·9
P5	0	30		8	16	

At 5 per cent all the oils examined, with the exception of L2, completely inhibited egg-hatching and a comparison of ovicidal properties is not possible. At 3 per cent differences in ovicidal action are apparent which have been expressed in Table 4 as χ^2. If χ^2 exceeds 3·841 the odds against such a difference arising by chance exceed 19 to 1 and, on the assumption that the eggs are of a uniform population, the difference may be accepted as significant. The results suggest that, on the whole, the physical factors of viscosity and boiling range exert a greater influence on ovicidal powers than the chemical factors expressed by iodine value or percentage of unsulphonated residue, for the values of χ^2 are greater in section (1) of the table. The difference shown between the oils L6 and P5 may, on this basis be attributed to differences in viscosity rather than to differences in iodine value for P5, which is inferior as an ovicide, has a greater viscosity than L6. It is apparent, however, from the relative inferiority of the oils P2 and L2 when compared to oils such as L3 and P3 that factors other than viscosity or boiling range play a part in determining ovicidal efficiency.

(*c*) *The Ovicidal action of semi-refined oils of different bases.*

In the 1931 field and laboratory trials evidence was obtained that the ovicidal and phytocidal actions of a semi-refined oil were not markedly different from those of a water-white oil of similar viscosity and boiling range. This conclusion is supported, for other oils, by the results described under section (*b*). Since, with the semi-refined oils, the characters of the crude oils will be more predominant than in the case of the water-white oils, it becomes necessary to determine to what extent the ovicidal efficiency of semi-refined oils is dependent on the source or base of the oil. It is a usual practice to classify petroleum oils, according to the nature of the residuum left after non-destructive distillation, into oils of paraffinic and asphaltic base. Intermediate in many ways between these two extremes are oils of naphthenic and of western base. The oils P3, 4 and 5 examined in section (*b*) were all of asphaltic base and for the trials to be recorded in this section, three oils of different viscosities of the remaining three bases were used. The characteristics of the samples used are recorded in Table 5, and the counts of hatched and unhatched eggs are shown in Table 6.

TABLE 5.

	Paraffinic base.			Naphthenic base.			Western base.		
	P6	P7	P8	P9	P10	P11	P12	P13	P14
Sp. Gr. (60° F.)	0·887	0·891	0·896	0·888	0·902	0·905	0·897	0·913	0·913
Viscosity, Redwood 1 @ 70° F. ..	210″	289″	420″	234″	524″	720″	167″	298″	420″
Boiling Range:									
1st drop	358	353	359	328	356	355	334	331	350
10% by vol. ..	368	374	387	349	373	378	344	347	365
20%	375	380	394	360	383	387	353	358	375
30%	379	387	399	370	389	394	362	365	383
40%	384	392	—	378	394	—	368	373	393
50%	388	397	—	387	—	—	375	383	—
60%	395	—	—	396	—	—	384	391	—
70%	—	—	—	—	—	—	394	400	—
Unsulphonated residue % by vol.	72·8	75·4	73·7	88·8	81·5	80·0	68·9	62·4	58*

* Oil layer difficult to distinguish from acid layer.

TABLE 6.

	At 5 per cent.		At 3 per cent.	
	Hatched.	Unhatched.	Hatched.	Unhatched.
Paraffinic base oils:				
P6	0	30	1	27
P7	0	27	0	36
P8	0	25	0	31
Naphthenic base oils:				
P9	0	33	0	31
P10	0	30	0	30
P11	0	25	8	16
Western base oils:				
P12	0	22	0	24
P13	0	35	11	19
P14	0	18	0	21

An adequate comparison of the ovicidal efficiency of the various oils is frustrated by their high potency, but two of the oils, P11 and P13 stand out as being markedly inferior. There is, however, no indication that this inferiority is associated with the base of the oil for they belong to different groups, the other members of which are efficient. In the case of P11, this inefficiency may be associated with high viscosity, but such an explanation cannot be advanced for the failure of P13. The degree of correlation between viscosity and ovicidal action of the eighteen samples of petroleum oils tested at 3 per cent may be estimated from the correlation coefficient. The method is not entirely satisfactory, for viscosity is intimately related to boiling range and it is probable that oils of low boiling range and consequently of low viscosity, will be inefficient ovicides. For this reason it must be assumed that the oils tested are all of boiling range high enough to escape the limiting factor of volatility. For the eighteen oils, the correlation coefficient "r" = 0·392 and for this value to have a significance greater than P = 0·5 it should exceed 0·4683. The closeness of the result to a figure which would indicate a significant correlation is due partly to the inclusion of the oil P5. If the results obtained with this oil, which has a viscosity far removed from the remaining oils, be omitted, "r" = 0·191. A similar examination of the interdependence of ovicidal efficiency and degree of refinement, taking as index of the latter the percentage by volume sulphonated, reveals a correlation coefficient of only 0·048, conclusive evidence that, with the range of oils tested, ovicidal efficiency is not related to the degree of refinement of the oils.

It is apparent that viscosity alone cannot be accepted as a sufficient criterion of ovicidal efficiency for the oils P8, P10 and P14, all of which completely inhibit egg-hatching when applied at 3 per cent, have higher viscosities than the oils L4 and P13, the incomplete ovicidal action of which has been associated with high viscosity. Further, the oil P12, which gives 100 per cent kill at 3 per cent, closely resembles in those characteristics which have been determined oils P2 and P4 both of which fail to give a complete control when applied at 3 per cent. Similarly, the oils L2 and L3 which coincide in the characteristics determined, are of different ovicidal powers ($\chi^2 = 5 \cdot 24$). It must therefore be concluded that there are factors other than those considered which may play a part in determining ovicidal efficiency.

(*d*) *The effect of the addition of tar oils on ovicidal properties of petroleum oils.*

It has previously been shown (Austin, Jary and Martin, 1932) that petroleum oils of the type used in these trials do not exert a sufficient ovicidal action on the eggs of aphis and apple sucker and that, to produce a wash of all-round efficiency, tar oils or other materials toxic to the eggs of these insects must be added to the petroleum oil. To investigate the effect of this addition on the action of the petroleum oil on capsid eggs, trials were made of washes prepared from 2 per cent of the tar oils T2 and T4 and 3 per cent of each of the representative petroleum oils L2, L4, P4 and P8. The results of egg counts are shown in Table 7.

TABLE 7.

	Hatched.	Unhatched.
T4 + L2	4	17
T2 + L2	0	23
T4 + L4	0	29
T4 + P4	0	33
T2 + P4	0	31
T4 + P8	0	24
T2 + P8	0	29

The oils L4 and P4, when used at 3 per cent in section (*b*), failed to kill all the eggs treated, but, when in combination with 2 per cent of the tar oil T4, 100 per cent efficiency was obtained. Similarly, the oils L2 and P4 were not completely effective at 3 per cent, but, on the addition of 2 per cent of the tar oil T2, they gave a complete kill of the eggs treated. The addition of 2 per cent T4 has not made the wash containing 3 per cent of the petroleum oil L2 completely effective. With the exception of this result, it would appear that the addition of tar oils has contributed to the ovicidal efficiency of the petroleum oil.

(*e*) *The influence of type of emulsification on ovicidal properties.*

The two-solution oleic acid method of emulsification, which was used for the preparation of all the washes described above, is not satisfactory with abnormally hard water. An alternative method, suitable for hard water, is to use Bordeaux mixture as the emulsifier, a process first used by Pickering (1907). Trials were accordingly undertaken to determine what influence the type of emulsification had on the ovicidal action of the petroleum oil. The four representative oils L2, L4, P4 and P8 were applied at 5 and 3 per cent emulsified with 4 : 6 : 100 Bordeaux mixture, and, in Table 8, the results are compared with the results obtained with the same oils emulsified by the two-solution oleic acid method.

No comparison is possible in the case of the oil P8, but, if the results with this oil be omitted, those obtained with oils L2, L4 and P4 show, when the sum totals of hatched and unhatched eggs are considered, that the type of emulsification has had no influence on the ovicidal efficiency of the oils. For sprays at 5 per cent, $\chi^2 = 0 \cdot 32$ and for sprays at 3 per cent, $\chi^2 = 0 \cdot 92$.

TABLE 8.

	Oleic acid emulsions.		Bordeaux emulsions.		
	Hatched.	Unhatched	Hatched.	Unhatched.	χ^2
L2: 5 per cent	3	31	0	28	2·8
3 per cent	4	23	11	21	3·0
L4: 5 per cent	0	26	0	28	—
3 per cent	11	17	3	30	7·9
P4: 5 per cent	0	28	2	37	1·5
3 per cent	7	20	5	22	0·4
P8: 5 per cent	0	25	0	29	—
3 per cent	0	31	0	37	—

(*f*) *Variance due to differences in the state of eggs or twigs.*

It has to be shown that the factor responsible for the low ovicidal efficiency of some of the oils tested is not variation in the state of the eggs or twigs tested. Further, the use of the χ^2 test to deduce the significance of the differences in ovicidal action obtained involves the assumption that the eggs examined are of a uniform population.

Proof of the satisfactory standardization of the biological material (i.e. eggs and twigs) is afforded, firstly, by the fact that an oil of relatively low ovicidal properties, e.g. L2 or P4, shows this inferiority in all the experiments made with that oil, secondly, by a consideration of the distribution of hatched and unhatched eggs throughout each set of twenty twigs. Table 9 shows the figures obtained for each twig in four typical examples, the number of hatched and unhatched eggs per twig occupying similar positions in each set of results.

TABLE 9.

Oil	Hatched	Unhatched	Oil	Hatched	Unhatched.
T2 (6 per cent)	10100 10110 10101 10112	11001 11001 00121 11010	T4 (6 per cent)	10110 11010 10100 00110	02001 01201 12011 12101
P5 (3 per cent)	01100 10100 11000 0011	10111 11021 00102 1210	P13 (3 per cent)	0110 12110 10100 10001	2111 20001 01021 21121

In those instances in the above Table where a full series of twenty counts is not given, the omissions are due to twigs which failed to root and on which the buds did not break normally. Such twigs were discarded for fear the eggs might have been adversely affected. In no case, with the exception of twigs treated with the petroleum oil P12 at 5 per cent, were there indications that the washes had caused injury to the buds. With the P12 wash, the leaves had a "scorched" appearance which may not have been due entirely to a drying-out of the twigs.

Five series of twigs, left untreated but subjected to the same conditions as the treated twigs, gave the counts of hatched and unhatched eggs recorded in Table 10.

TABLE 10.

	Hatched.	Unhatched.
Series a	23	2
Series b	29	0
Series c	33	0
Series d	27	1
Series e	32	0

From these results it may be deduced that the conditions under which the twigs were kept in no way prejudiced the normal development of the eggs.

2. FIELD TRIALS.

The main purposes of the field trials to be described below were :

(1) To examine the general action of winter washes prepared from various tar and petroleum oils.

(2) To determine the effect of the substitution, for the high-boiling neutral tar oil used in the 1931 trials, of strained anthracene oil or dinitro-*o*-cresol.

(3) To compare the action of washes prepared by the two-solution oleic acid method and the Bordeaux mixture method of emulsification.

Trials were carried out on bushes of red and of black currants known to be heavily infested with eggs of the capsid bug *Lygus pabulinus* Linn., and the control of this insect was the primary object of the trials. Four trials were also made on various varieties of apple and at three of the centres where the capsid bug *Plesiocoris rugicollis* Fall. was present, observations were mainly concentrated on the effect of the washes on the eggs of this insect. At the fourth centre where the apple capsid bug was not present, the oil concentration of the washes was reduced and a direct comparison made of the two methods of emulsification.

For the preparation of the washes by the oleic acid method of emulsification, the amounts of tar and petroleum oils required per 100 gals. of wash were mixed with 1 gal. of brown commercial oleine of the following specification : Acidity, 95-100 per cent expressed as oleic acid ; Iodine value, 80-90 , Clearing point 9-12° C. This mixture was then added to the amount of water required to make up the volume to 100 gals. in which was previously dissolved 1½ lb. flake caustic soda. For the washes prepared by the Bordeaux mixture method, the amounts of tar and petroleum oils required for 100 gals. of wash were mixed with 4 gals. of 10 per cent bluestone solution and the mixture poured into a suspension of 6 lb. hydrated lime in the amount of water required to bring the volume of wash to 100 gals. After stirring, emulsification was completed by pumping the mixture through the spraying machine back into the spray tank, by which process a uniform emulsion was produced in a few minutes.

The analyses of the oils used in the field trials are given in Table 11, with the exception of the oils T2 and P2, which are given in Table 1 (p. 65) and P5 which appears in Table 3 (p. 66).

TABLE 11.

	Tar oils.		Petroleum oils.		Diesel oil.
	T5	T6	P15	P16	D
Neutral oil, % by weight ..	87·4	88·9	—	—	—
Tar acids, do.	4·3	4·9	—	—	—
Tar bases, do.	6·9	5·7	—	—	—
Sp. Gr. (60° F.)	1·108	1·111	0·897	0·899	0·864
Viscosity, Redwood 1 @ 70° F.	107″	—	161″	167″	45″
Boiling Range :					
1st drop	(Water)	(Water)	334	335	222° C.
10% by vol.	277	267	345	347	238
20%	296	292	353	354	253
30%	310	313	361	362	265
40%	322	327	369	369	278
50%	333	338	376	375	291
60%	343	351	—	385	306
70%	357	363	—	394	323
80%	367	379	—	—	346
Unsulphonated residue, % by vol.	—	—	69.6	68·2	66·2
Methyl sulphate, % by vol. insol.	0·0	0·0	100·0	100·0	87*

* Presence of precipitate makes oil layer difficult to distinguish.

(*a*) *Red Currants.*

We are indebted to A. Amos, Esq., Spring Grove, Wye, who allowed us to use a block of red currants of the variety Fay's Prolific for the purpose of this trial. The block, which contained 960 bushes, was divided into sixteen plots each containing 4 by 15 bushes. The four treatments, which were randomized on the basis of a Latin square, were unsprayed and the following three sprays :

T2P2 .. 4 per cent " Long Ashton " tar oil and 6 per cent semi-refined petroleum oil P2.

T5P2 .. 4 per cent strained anthracene oil T5 and 6 per cent petroleum oil P2.

C.P15 .. 6 per cent semi-refined petroleum oil P15 and the potassium salt of dinitro-*o*-cresol in amount required to give 0.2 per cent dinitro-*o*-cresol.

The washes were applied on 5 February by means of a power machine operating two lances.

Ovicidal Action : For the estimation of the ovicidal effect of the washes, four bushes were selected at random from the inner twenty-six bushes of each plot and the number of shoots showing capsid-marked leaves were counted. Table 12 shows the arrangement of the treatments and the number of shoots with marked leaves for each set of four bushes. The bushes were small enough to permit counts of the actual number of shoots even of bushes in the untreated plots, for which the total number of shoots is also given. Thus, 114/167 indicates that on the four bushes examined, 114 shoots out of a total of 167 showed typical capsid markings.

TABLE 12.

C.P15 18	T5P2 8	T2P2 5	Unsprayed 114/167
Unsprayed 78/109	T2P2 2	T5P2 0	C P15 32
T5P2 3	Unsprayed 144/173	C P15 36	T2P2 3
T2P2 5	C.P15 17	Unsprayed 109/144	T5P2 1

Combining the counts to give the results per 16 bushes:

Unsprayed .. .. 445 shoots infested out of 593,
C.P15 .. .. 103 shoots infested,
T2P2 .. .. 15 shoots infested,
T5P2 .. .. 12 shoots infested.

It will be seen that the oil P2, whether in combination with the tar oil T2 or T5, gave an excellent control of the capsid which was, from the practical standpoint, complete. The wash C.P15 did not give as good a result. As in other field trials described below the oils P2 and P15, which are of similar characteristics, were found to possess similar ovicidal properties; the relative failure of the C.P15 combination must be explained in other ways. Two possibilities are suggested, firstly, that the inclusion of the potassium dinitro-*o*-cresylate has interfered with the action of the petroleum oil or, secondly, that the lesser efficiency is related to the lower oil concentration of the C.P15 wash. The second explanation appears to agree with the indications obtained in the laboratory tests, that the addition of tar oil contributes to the ovicidal efficiency of the wash against the eggs of the capsid bug.

Phytocidal Action: No indications were obtained that any of the three treatments had caused bud or foliage damage.

(*b*) *Black Currants.*

We are indebted to Sir W. Berry, Gushmere Court, Faversham, for permission to use a block of 400 bushes of the variety Baldwin for this trial. The block was divided into a Latin square of sixteen plots, each plot containing 5 by 5 bushes. The washes used were as follows:

T2P2 .. 4 per cent "Long Ashton" tar oil T2 and 6 per cent semi-refined petroleum oil P2.

T5P15 (10%) .. 4 per cent strained anthracene oil T5 and 6 per cent semi-refined petroleum oil P15.

T5P15 (7%) .. 3 per cent T5 and 4 per cent P15.

Washing was carried out on 4 February with a manual machine operating two lances.

Ovicidal Action: Counts of shoots with capsid-marked leaves were made on 1 June, two bushes being selected at random from the inner nine bushes of each plot. The bushes were so large that counts of the total number of individual shoots were impossible and the

percentage figure, given in Table 13, is the average estimate of two independent observers of the percentage of shoots infested on the unsprayed bushes. On the treated plots it was possible to count the total number of shoots with marked leaves. The following figures, in totals per eight bushes were obtained:

Unsprayed	82 per cent shoots infested,
T5P15 (7%)	10 shoots infested,
T5P15 (10%)	6 shoots infested,
T2P2	5 shoots infested.

TABLE 13.

Unsprayed 75% infested	T2P2 0	T5P15 (7%) 0	T5P15 (10%) 3
T5P15 (10%) 0	T5P15 (7%) 3	Unsprayed 85% infested	T2P2 0
T5P15 (7%) 7	T5P15 (10%) 0	T2P2 5	Unsprayed 80% infested
T2P2 0	Unsprayed 90% infested	T5P15 (10%) 3	T5P15 (7%) 0

The results indicate that all the washes used have given an excellent commercial control of eggs of the common green capsid and that the reduction of oil concentration to 7 per cent, in the case of the T5P15 wash, has resulted in only a slight reduction of ovicidal efficiency of doubtful significance.

Phytocidal Action: At the time of application of the washes the buds were in an advanced stage of growth for the season, a few leaves almost half an inch in diameter being present. When the plots were visited on 11 May, no sign of injury was apparent and no damage of any kind appeared to have been caused.

(*c*) *Worcester Pearmain Apples.*

The trials described in sections (*c*) and (*d*) were carried out on trees kindly placed at our disposal by E. Vinson, Esq., Kemsdale, Faversham. A block of 500 trees of Worcester Pearmain was divided into a Latin square of twenty-five plots, each plot containing eight trees. They were known to be heavily infested with eggs of the apple capsid bug, *Plesiocoris rugicollis*, and a large proportion of the crop had been annually attacked. The trees were all of the bush type, about fifteen years old, and well spur-pruned so that they admitted of thorough washing. The washes, which were applied on 3 February by means of a small power machine operating two lances, were as follows:

T2P2	4 per cent "Long Ashton" tar oil T2 and 6 per cent semi-refined petroleum oil P2.
T5P15	4 per cent strained anthracene oil T5 and 6 per cent semi-refined petroleum oil P15.
T5P5	4 per cent T5 and 3·5 per cent semi-refined highly viscous petroleum oil P5.
D.P15	4 per cent Diesel oil D and 6 per cent petroleum oil P15.

The semi-refined oil of high viscosity, P5, was included in order to compare the action of light and heavy oils on the eggs of red spider *Oligonychus ulmi* Koch., and the Diesel type of oil, D, was applied as a substitute for tar oils in order to compare the action of a petroleum oil rich in unsaturated and aromatic hydrocarbons on the eggs of aphis and psylla with that of tar oil. The methyl sulphate solubility figure for the Diesel oil indicates a content of about 12 per cent aromatic hydrocarbons.

Ovicidal Action: (1) *Aphides.* The infestation by aphides was generally small and when the plots were examined on 28 June, was noticeable on only two of the untreated plots. All the washes gave trees free from aphides with the exception of D.P15. Small colonies were found on two plots under this treatment, an indication that the Diesel oil was not as effective as the tar oils in its action on the eggs of aphides.

(2) *Red spider.* The eggs of this mite were present during the winter in moderate numbers on the trees. Estimations of red spider infestation were made during the early summer but showed no differences which could be related to the various treatments. This may perhaps be accounted for by the fact that all the trees received applications of lime-sulphur in the ordinary course of spring spraying.

(3) *Apple capsid bug.* At fruit-picking the crop was graded and the numbers and weight of clean and capsid-marked apples recorded from each tree. All fruits which showed even slight markings were included in the capsid-marked grade. In Table 14, the totals of the five plots in each treatment are given.

TABLE 14.

Treatment.	Number.		Weight.	
	Total.	Percentage capsid-marked.	Total lb	Percentage capsid-marked.
Unsprayed	9191	48·6	1862	45·7
T2P2	11503	1·3	2413	1·2
T5P15	12116	2·2	2495	2·1
T5P5	13368	21·5	2687	20·7
D.P15	13363	3·4	2667	2·8

The high degree of capsid control given by the washes T2P2, T5P15 and D.P15 is clearly apparent and the wash T5P5 is definitely inferior. This inferiority may be associated with the lower oil concentration of this wash, namely, 7·5 per cent as compared with 10 per cent in the other washes, or it may be related to the high viscosity of the petroleum oil P5 present. To determine whether there was a significant difference in the ovicidal action of the three efficient washes, a statistical examination of the number of capsid-marked apples per plot was made, omitting plots unsprayed or washed with the T5P5 wash. The results of an analysis of variance are shown in Table 15.

TABLE 15.

Variance due to	Degrees of freedom.	Variance σ^2	$\frac{1}{2}\log_e\sigma^2$
Blocks	4	—	—
Treatments	2	4674·5	4·2249
Error	8	680·0	3·2610
			"z" = 0·9639

As " z " exceeds 0·7475 the odds against the difference in variance occurring by chance exceed 19 to 1 and there is a significant difference in the numbers of capsid-marked apples per treatment. Calculation of the average number of capsid-marked apples per plot per treatment and of the significant difference gives the following :—

T2P2	.. ..	30·8 capsid-marked apples per plot,
T5P15	.. ..	54·0 capsid-marked apples per plot,
D.P15	.. ..	91·4 capsid-marked apples per plot.

Significant difference = 38·05.

The wash D.P15 is therefore significantly inferior to the wash T2P2 in the control of capsid bug under the conditions of this trial, but there is no difference between the washes D.P15 and T5P15 or between T5P15 and T2P2.

Phytocidal Action : An inspection of the trees on 15 May showed that some retardation of the buds had been caused by all the washes. It was on the whole erratic in character and the following notes were made on this date :

Unsprayed trees : Normal.
T2P2—Slight retardation of bud opening and some damage to fruit buds, less than on D.P15.
T5P15—Erratic damage, more on some trees than on others ; some retardation of foliage buds.
T5P5—Very slight damage and little retardation of blossom buds.
D.P15—Some retardation of both fruit and leaf buds ; slight damage, rather more than on T5P5.

By 28 May when the next inspection was made, practically all traces of injury had disappeared and the treated plots could not be distinguished from the unsprayed plots except in regard to the presence or absence of insect pests. The counts of total fruit given in Table 14 indicate that the amount of bud damage was negligible, though it should be observed that the trees carried a heavy blossom which set well.

(*d*) *Lane's Prince Albert Apples.*

The block of eighty trees, in twenty rows of four trees per row, was divided into four plots of four rows separated by guard rows. Within each plot four treatments (unsprayed and three washes) were randomized, the position of each treatment being given in Table 18. The trees were of bush type, twelve to fifteen years old, and spur-pruned so that thorough washing was possible. The following washes were applied on 3 February with the same machine as that used for the Worcesters :—

T2P2	.. ..	4 per cent " Long Ashton " tar oil T2 and 6 per cent semi-refined petroleum oil P2.
T5P2	.. ..	4 per cent strained anthracene oil T5 and 6 per cent P2.
T5P15	.. ..	4 per cent T5 and 6 per cent semi-refined petroleum oil P15.

The guard rows were washed with the T5P2 mixture.

Ovicidal Action : (1) *Red spider.* The whole block was heavily infested with this mite and the foliage was eventually badly damaged. Estimates of the infestation per tree were made on 3 August, but the intensity of attack was found to be very variable

and not always related to winter-wash treatment or to the position of the trees. Although on the whole all the washes appeared to have reduced the attack to some extent, a statistical examination of the estimates showed that no significant difference due to treatment could be found.

(2) *Apple capsid bug.* The fruit was graded as with the Worcesters and the total counts and weight of crop per treatment are shown in Table 16. From this Table, in

TABLE 16.

Treatment	Number.		Weight.	
	Total	Percentage capsid-marked	Total lb.	Percentage capsid-marked
Unsprayed .. .	1981	64·0	527·5	52·7
T2P2	715	10·9	266·5	8·1
T5P15	956	11·2	383·5	9·2
T5P2	1163	15·3	408·5	13·9

which the crop from the guard rows is not included, it is evident that all the washes have substantially reduced the capsid population, though apparently not to the same extent as on the Worcesters. The crop, however, was not nearly as large as on the Worcesters and, since a few capsids will mark a larger proportion of apples on a thin crop, this may serve to explain why the percentage of marked fruit is relatively high. The differences between the capsid-marked fruit on the sprayed and unsprayed trees are so large that the latter may be omitted from the statistical examination of the numbers of capsid-marked fruit per tree, which then gives the analysis of variance shown in Table 17. For the difference in variance between treatment and error to be significant, " z " should exceed 0·59. It may be concluded therefore that the differences in ovicidal action given by the washes T2P2, T5P15 and T5P2 are not significant, and may have arisen by chance or through position.

TABLE 17.

Variance due to	Degrees of freedom	Variance σ^2	$\frac{1}{2}\log_e\sigma^2$
Blocks	3	274·2	—
Treatment	2	158·75	2·5338
Error between rows ..	6	45·88	—
Error within rows ..	36	55·26	2·0061
			" z " = 0·5277

Phytocidal Action : An inspection of the trees on 11 May showed that the washes had all caused a considerable amount of damage to the fruit buds. On some trees both blossom and wood buds were affected and the following notes were taken on that date.

Unsprayed trees : Normal.

T2P2—Very erratic leaf and blossom bud damage ; on some trees the leaf buds are retarded and the blossom buds are normal, and on other trees *vice versa.*

T5P2—Leaf buds generally retarded less than on T5P15 ; blossom buds also retarded with considerable damage, less on rows 12, 16 and 18.

T5P15—Leaf buds considerably retarded and many blossom buds killed.

Subsequently it appeared that the effect on the wood buds was only in the nature of a temporary check for the foliage on the washed trees eventually became indistinguishable from that of the unsprayed. Many of the fruit buds, however, were definitely killed, and counts of the number of flower trusses showed a serious loss. In Table 18, the average number of blossom trusses per yard of wood of branches selected at random from each tree are given.

TABLE 18.

Treatment.	Row.	No. blossom trusses per yd. of wood.			
Unsprayed	2	12	20	15	12
	10	25	2	8	20
	13	20	15	20	25
	19	20	30	25	25
T5P15	3	1	4	7	4
	7	12	14	12	15
	14	12	10	8	10
	20	10	14	20	20
T2P2	4	10	10	7	8
	8	20	20	7	10
	15	12	5	15	10
	17	15	10	10	12
T5P2	1 (Guard)	5	7	6	5
	5	5	8	7	20
	6 (Guard)	12	10	12	6
	9	7	10	12	8
	11 (Guard)	5	5	20	12
	12	25	25	8	8
	16 (Guard)	25	15	15	15
	18	20	15	15	20

The effect of the blossom bud damage is also shown in the amount of crop produced. A statistical examination of the total number of apples picked per tree is shown in Table 19. "z" for blocks and treatments = 0·9894 and 1·0313 respectively, and

TABLE 19.

Variance due to	Degrees of freedom.	Variance σ^2	$\frac{1}{2}\log_e\sigma^2$
Blocks	3	26925	5·1006
Treatments	3	29292	5·1425
Error between rows	9	5203	4·1112
Error within rows	48	2336	—

as both values exceed 0·52, the value which is appropriate for odds of 19 to 1 against chance, differences due to position and treatment are significant. The average number of apples picked per tree for each treatment are: Unsprayed, 123·8; T2P2, 44·7; T5P15, 59·7; T5P2, 72·7. The significant difference, based on the composite standard error, is 61·4 and it may therefore be concluded that the washes, with the exception of T5P2, have caused a significant reduction of the fruit picked, and that the differences between the washes are not significant.

(e) *Bramley's Seedling Apples.*

The object of this experiment and of that described under (*f*), was to test the relative efficiency of the oleic acid and Bordeaux methods of emulsification. The trees used were about twenty-five years old, half standards in grass, and twelve rows of these were divided into four blocks in which three treatments (unsprayed and two washes) were randomized. The oil used for the two washes was a mixture of equal volumes of the strained anthracene oil T5 and of the semi-refined petroleum oil P15. As the apple capsid bug was not present, the oil concentration used was 8 per cent, emulsified in one treatment with 1 per cent oleic acid and 0·15 per cent sodium hydroxide, and in the other treatment with 4 : 6 : 100 Bordeaux mixture. The washes were applied by means of a small power machine operating two lances.

Ovicidal and Phytocidal Actions: The only insects present on the trees in any numbers were aphides ; winter moth caterpillar and sucker infestation were small. An estimate of the insect population was made on 21 April and gave the following results :

	Aphis.	Caterpillar.	Psylla.
Unsprayed trees .			
Row 2	4*	0	0
Rows 6 and 7 ..	4	0	0
Row 12	5	1	Trace
Sprayed trees :	0	0	0

* 10 = 100 per cent infestation.

Both types of emulsification produced a satisfactory wash which gave complete control of the pests present and no difference could be observed between the two types, a conclusion similar to that obtained in laboratory tests on eggs of the common green capsid. Neither wash had any injurious action on the buds and all the trees subsequently carried a large crop.

(*f*) *Lord Derby Apples.*

We are indebted to Mr. B. D. Champion, Mereworth, for the loan of part of a plantation of trees of the variety Lord Derby. The trees, about 240 in number, were divided into four randomized blocks of five treatments, each plot containing ten or more trees. Mr. W. Steer, of the East Malling Research Station, co-operated in this trial and the following data only summarizes the results obtained. A fuller account will appear in the Report of the East Malling Research Station for 1933.

The sprays used were as follows :

T6P16 (Oleic emulsion), containing 4 per cent strained anthracene oil T6 and 6 per cent semi-refined petroleum oil P16, emulsified with 1 per cent oleic acid and 0·15 per cent sodium hydroxide.

T6P16 (Bordeaux emulsion), containing the above tar-petroleum oil mixture emulsified with 4 : 6 : 100 Bordeaux mixture.

P16 (Oleic emulsion), containing 6 per cent P16.

T6 (Oleic emulsion), containing 4 per cent T6.

The washes were applied on 16 and 17 February with a power spraying machine operating four lances.

Ovicidal Action : Whereas on the unsprayed trees and those receiving tar oil alone, damage by capsid bugs was in evidence throughout the season, the petroleum and tar-petroleum washes had obviously greatly reduced the infestation. The crop from the three innermost trees of each plot was picked, graded and weighed and the results are shown in Table 20. A statistical examination of the mean percentage of fruits marked per plot of three trees showed that there is no significant difference between the results from the unsprayed plots and those washed with tar oil alone, nor between the ovicidal efficiency of the three washes containing petroleum oil, i.e. T6P16 (oleic emulsion), T6P16 (Bordeaux emulsion) and P16 (oleic emulsion).

TABLE 20.

Treatment.	Number.		Weight.	
	Total.	Percentage capsid-marked.	Total lb.	Percentage capsid-marked.
Unsprayed	2191	23·9	682	23·7
T6	1919	16·8	592	15·2
P16	2237	2·2	764	1·8
T6P16 (Bordeaux) ..	1424	1·0	489	1·0
T6P16 (Oleic).. ..	984	0·4	359	0·3

Phytocidal Action : The washes which contained 10 per cent of oil all had a marked effect on the leaf and fruit buds. The leaf buds were considerably delayed, but eventually opened normally and no permanent damage was caused, but in the case of the fruit buds, many were killed and fell from the trees. A large proportion of the buds so affected proved, on examination, to be attacked by various fungi. Such diseased buds were also numerous on unsprayed trees but required a close examination to reveal their presence. It would appear that buds and fruit spurs affected by fungus diseases are more readily killed by the oil washes. A statistical examination of the total numbers of apples picked per plot of three trees revealed no significant difference due to treatment.

(*g*) *Miscellaneous Trials :*

(1) *The influence of weather conditions at time of spraying on the phytocidal action of tar-petroleum washes.*

It is now generally agreed that the application of high concentrations of tar oils at a time when the tree is not completely dormant is likely to result in bud damage, and it seemed possible that the application of the wash after a mild spell in the dormant season might be more likely to cause injury than an application after a severely cold spell. A wash containing 4 per cent strained anthracene oil T5 and 6 per cent semi-refined petroleum oil P15, emulsified by the oleic acid method, was applied by means of a knapsack sprayer to a row of espalier apple trees of the variety Newton Wonder on 16 January, after a mild spell. Half only of each tree was washed. Colder weather set in soon afterwards and continued up to 19 February, when the remaining halves of the trees were washed with the same spray. Observations of the bud and blossom opening showed

no indications of differences or retardation between the differently treated halves of the trees nor were there signs of bud damage. These trees were growing under garden conditions of cultivation and were very vigorous in habit.

(2) *The action of vegetable oil emulsions on aphis eggs.*

The 1931 laboratory tests showed that vegetable oils are more effective in controlling the eggs of the common green capsid on currants than tar oils applied at the same concentration and it became necessary to examine the action of vegetable oils on aphis eggs for, if effective, the vegetable oils would be worth trial as substitutes for the combined tar-petroleum oil. For the purpose of the trial small potted apple trees of the varieties Cox's Orange Pippin, Worcester Pearmain and Bramley's Seedling were treated with the following washes, one tree being used for each wash.

6 per cent crude expressed oil of mustard :—300 ml. oil was added to 4,700 ml. water containing 30 ml. 10 per cent sodium hydroxide.

6 per cent cotton-seed oil :—300 ml. of a cheap grade of edible cotton-seed oil were mixed with 50 ml. oleic acid and added to 4,600 ml. water containing 75 ml. 10 per cent sodium hydroxide.

The washes were applied on 8 February by means of a knapsack sprayer, one branch on each tree being protected from the spray by insertion in a paper bag which was not removed until the wash had dried.

When examined on 16 May, newly-hatched corn-apple aphis (*Rhopalosiphum prunifoliae* Fitch.) were plentiful on all varieties. The washes had clearly failed to control the aphis.

Our thanks are due to the undermentioned firms who supplied samples of oils for use in the laboratory tests : Messrs. Shell-Mex and B.P., Ltd., and Messrs. Sternol, Ltd., for various petroleum oils ; to the South Metropolitan Gas Co. for samples of tar oils ; to Messrs. J. & J. Colman, Ltd., for the sample of crude expressed oil of mustard. Messrs. Shell-Mex and B.P., Ltd. also gave a supply of petroleum oils for use in field trials. We are further indebted to Messrs. Holder-Harriden, Ltd., for the loan of an " Autofix " motor sprayer which was used in one of the field trials.

SUMMARY.

1. Laboratory tests of the ovicidal efficiency of various oils on the eggs of the common green capsid *Lygus pabulinus* Linn. gave the following results :

(*a*) At 6 per cent, petroleum and vegetable oils are more effective ovicides than tar oils.

(*b*) Of eighteen petroleum oils of different characteristics and bases, all, with the exception of one, gave a complete control of the capsid when applied at 5 per cent ; at 3 per cent there were differences in ovicidal efficiency. No correlation was found between ovicidal efficiency and the base or degree of refinement of the oils examined. There was a tendency for oils deficient in ovicidal properties to be of relatively high viscosity but other factors, not represented in the characteristics determined, appear to be concerned in determining the ovicidal efficiency of the oils.

(*c*) The addition of high-boiling tar oils resulted in an increased ovicidal efficiency of the petroleum oil washes.

(*d*) With the oils tested, no difference was found in the ovicidal efficiency between emulsions prepared by the two-solution oleic acid method and by the use of Bordeaux mixture.

2. Field trials of various tar-petroleum oil mixtures emulsified in all trials by the oleic acid method and, in trials (*e*) and (*f*), by means of 4 : 6 : 100 Bordeaux mixture, gave the following results :

(*a*) On red currants, washes containing 6 per cent semi-refined petroleum oil and 4 per cent strained anthracene oil or a high-boiling tar oil conforming to the Long Ashton specification gave an excellent control of the common green capsid, *L. pabulinus*. A wash containing 6 per cent of a similar petroleum oil and potassium dinitro-*o*-cresylate, in amount adjusted to give 0·2 per cent dinitro-*o*-cresol, gave an inferior control of this capsid. No injury to the bushes was caused by any of the three washes.

(*b*) On black currants, washes containing 6 per cent petroleum oil and 4 per cent of one of the above tar oils gave an excellent control of *L. pabulinus* and caused no injury to the bushes. A reduction of the oil concentration to 4 per cent petroleum oil and 3 per cent tar oil did not cause a decrease of ovicidal efficiency.

(*c*) Four washes of the following composition were applied to Worcester Pearmain apples : (1) 6 per cent semi-refined petroleum oil and 4 per cent " Long Ashton " tar oil ; (2) 6 per cent of a similar petroleum oil and 4 per cent strained anthracene oil ; (3) 3·5 per cent semi-refined heavy petroleum oil and 4 per cent strained anthracene oil ; (4) 6 per cent petroleum oil and 4 per cent crude petroleum oil of a Diesel type. All the washes with the exception of (4), gave a complete control of aphis and all, with the exception of (3) gave a high degree of control of the apple capsid (*Plesiocoris rugicollis*). The washes caused a retardation of bud opening which did not result in permanent damage.

(*d*) Three washes of the following composition were applied to Lane's Prince Albert apples : (1) 6 per cent semi-refined petroleum oil and 4 per cent " Long Ashton " tar oil ; (2) 6 per cent of the same petroleum oil and 4 per cent strained anthracene oil ; (3) 6 per cent of a similar petroleum oil and 4 per cent strained anthracene oil. All the washes gave a commercial control of apple capsid but caused serious injury to the fruit buds. No differences were found in the ovicidal or phytocidal actions of the washes.

(*e*) A tar-petroleum oil mixture consisting of 4 per cent strained anthracene oil and 4 per cent semi-refined petroleum oil, emulsified in one treatment, by the oleic acid method and, in a second treatment, with 4 : 6 : 100 Bordeaux mixture, was applied to Bramley's Seedling apples. The washes proved equally effective as general winter washes and caused no injury to the trees.

(*f*) The following four washes were applied to Lord Derby apples : (1) 6 per cent semi-refined petroleum oil and 4 per cent strained anthracene oil emulsified by the oleic acid method ; (2) the same tar-petroleum oil mixture emulsified with 4 : 6 : 100 Bordeaux mixture ; (3) 6 per cent of the petroleum oil and (4) 4 per cent of the tar oil, both emulsified by the oleic acid method. The petroleum and the tar-petroleum washes gave an excellent control of the apple capsid but the wash containing tar oil only was ineffective. The washes containing 10 per cent oil caused serious bud damage.

(*g*) The wash containing 6 per cent semi-refined petroleum oil and 4 per cent strained anthracene oil, emulsified with oleic acid, was applied at different times to

Newton Wonder apples ; in one case, following a mild spell and, in the second, following a later cold spell. No damage resulted nor were differences shown in the time of bud opening.

Vegetable oils applied at 6 per cent proved ineffective against the eggs of the corn-apple aphis, *Rhopalosiphum prunifoliae.*

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FURTHER INVESTIGATIONS INTO PENETRABILITY OF STEEL POINTS AND SOIL CONSOLIDATION

By CORNELIUS DAVIES,
Head of the Department of Engineering.

THE PENETRABILITY OF STEEL POINTS.

Some work described in this *Journal* for 1931 (1) which was done with the aid of the Davies compactometer showed that $\frac{5}{16}$ in. diameter steel probes of various shapes had degrees of penetrability into soils not always in agreement with preconceived ideas. Further investigations have been made with similar shapes but with larger diameters.

I had found in previous experiments that a comparatively sharp cigar shaped probe, labelled A in my paper of 1931, (1) offered more resistance to insertion into soils than a square-ended one and several others with different points. This particular shape, A, has been reproduced on a larger scale with a diameter of $\frac{1}{2}$ in., labelled 3 in Fig. 1 in the present paper, as well as a number of other shapes of the same diameter, all illustrated in the same figure. Similar results have been obtained with the larger

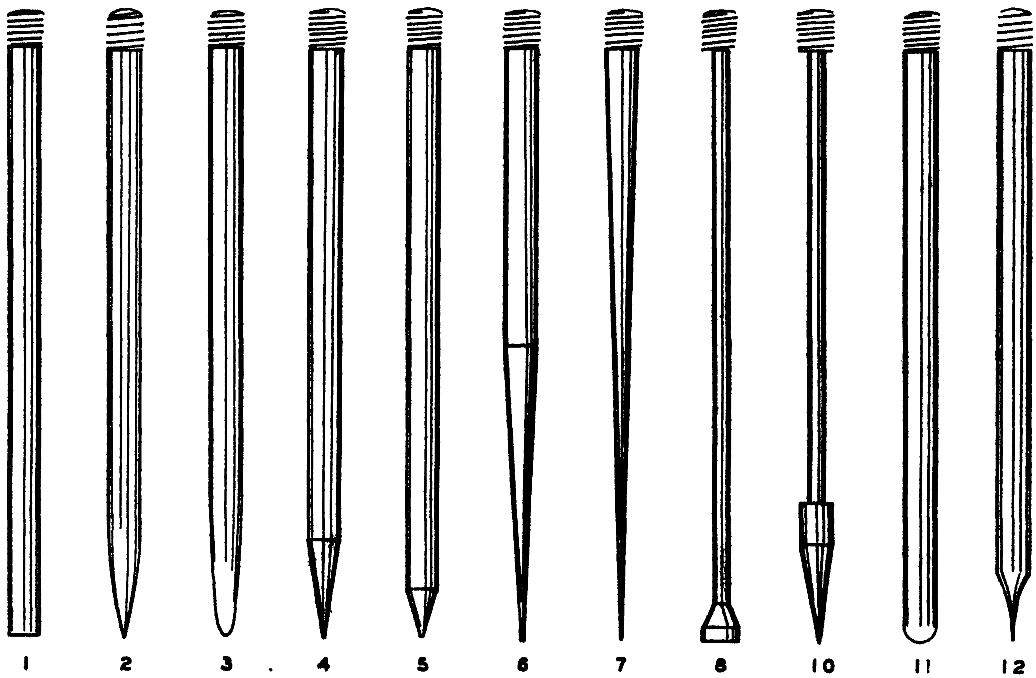

Fig. 1.
The probes used in the experiments.

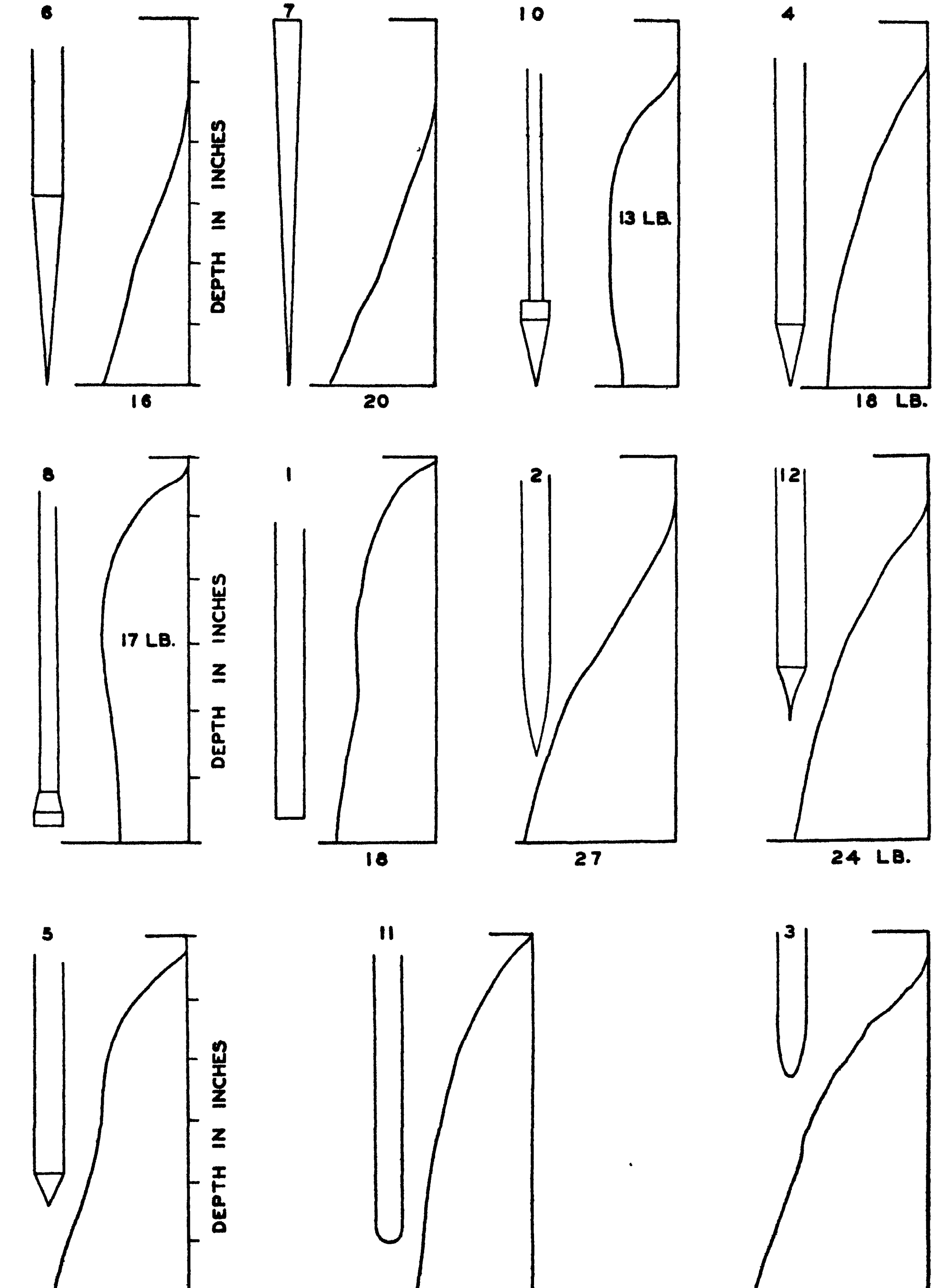

Fig. 2.
The probes and the depth-consolidation curves obtained with them.

model, that is, this shape is harder to force into soils than the others. Again I cannot offer any satisfactory explanation ; but it seems that a probe having any convexity, or concavity—such as 12—on the sloping portion of the point is more difficult to pass through soil than " straight line " ones.

The difficulty of obtaining uniform soils for testing purposes was previously mentioned. A large box has now been constructed to hold a loam. To get conditions of consolidation as uniform as possible the soil was passed through a $\frac{1}{8}$ in. mesh sieve and built up in layers of about 1 in. at a time. Each layer was soaked by sprinkling with water through a rose and the soil was allowed to settle for several months before any experiments were conducted in it. Tests showed that the consolidation was more uniform in the box than in any of the natural soils or sands which we tried in our own district, the deviations, in most cases, of any probe's curves from the mean being but slight.

Fig. 2 shows the curves obtained with the various $\frac{1}{2}$ in. probes, arranged in order of penetrability. The area of the curves has been taken as the measure of the effort required to insert to depths of 6 in. ; but the maximum pressure exerted in every case has also been noted and is given on the curves. It will be seen that some of the probes, especially the " cut-away " ones, required a decreasing effort as they progressed downwards. I am now conducting experiments with a mechanical device which applies a steady pressure to find out to what extent the effort of the human muscles contributes to any error. All the results up to the present have been obtained by pressing the compactometer by hand.

I have assumed that the differences in effort (where there are differences), are significant, because, as previously stated, the deviation of any one curve from the mean was so slight.

Fig. 3 summarizes the results obtained with two of the $\frac{5}{16}$ in. probes when sawdust and mixtures of sawdust and loam were used as the media for tests of penetrability. The blunt probe X required more force for insertion into dry sawdust than A ; but when a 1 : 1 mixture of loam and sawdust was employed the differences were less, as is seen in Fig. 3b, and still less when three parts of dry loam to one of sawdust was the medium, Fig. 3c. When the three to one mixture was moistened the differences were further decreased and the curves actually crossed about 5 in. down.

Into various soils it required less force to insert the blunt probe X than the comparatively sharp probe A.

All these further experiments seem to confirm the deduction previously made that all penetrating tools and perhaps all cutting tools have a shape best suited to the material being pierced or cut. These investigations are being continued and extended.

Consolidation Studies in the Field.

An improved form of chart holder has been designed and made for the compactometer. This takes the form of a plate holding a roll of paper about 16 ft. long which is carried on two spools, a mechanism similar to that of a roll film camera. This has been found more convenient on windy fields than the separate sheets of paper previously employed. The compactometer is now being made by Messrs. A. Gallenkamp & Co., Ltd.

The following curves, each of which is the mean of at least thirty readings, give an idea of the effects on consolidation, inch by inch downwards, of rollers, furrow-presses, tractor wheels and other soil packing agents. It was not convenient to conduct trials

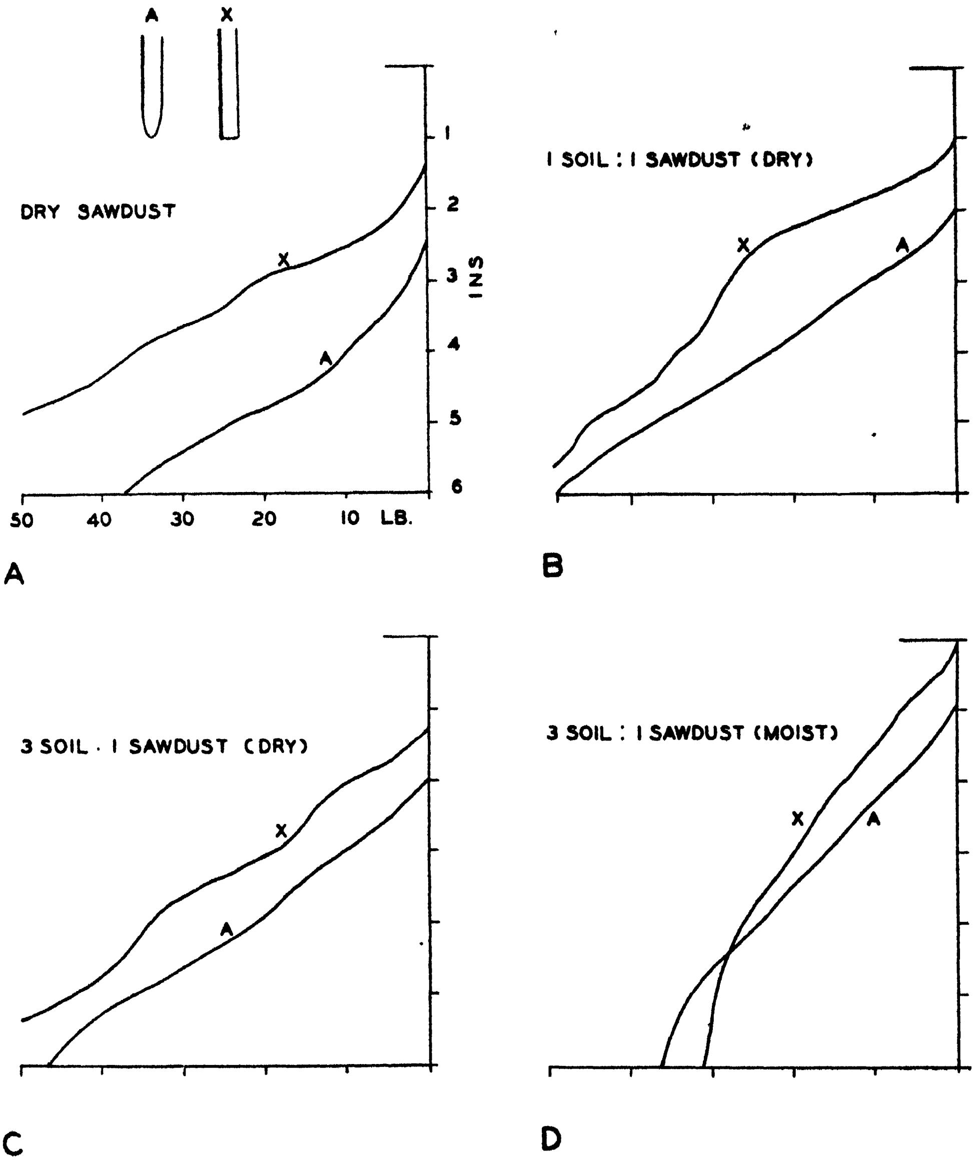

Fig. 3.

in all cases to study the effects on yield because commercial crops were being grown on our plots and the marking out of experimental areas was not possible. A brief indication of the conditions is given under each set of curves.

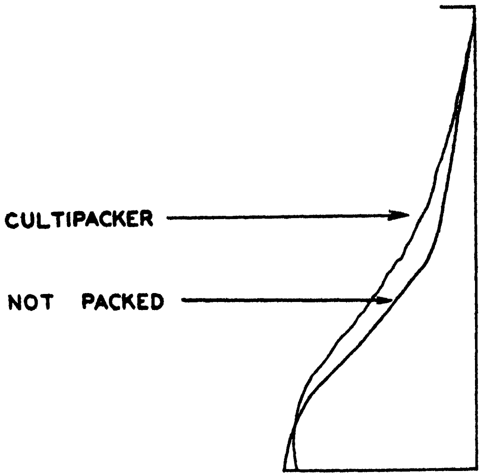

Fig. 4.

17 March 1932. Loam, dry when measured, ploughed, tractor cultivated, horse drilled and harrowed. Consolidated with a horse-drawn tandem cultipacker. No yield trial.

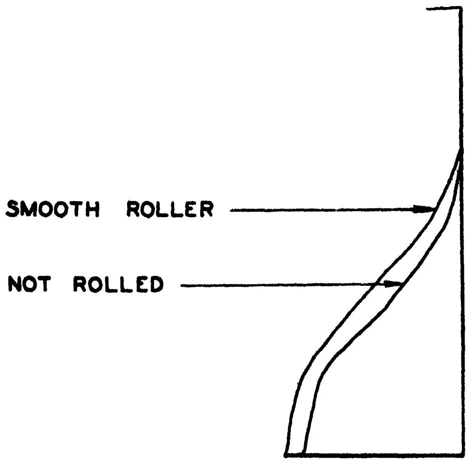

Fig. 5.

26 April 1932. Loam, dryish when measured, ploughed, cultivated and harrowed. Consolidated with a horse-drawn smooth roller. No yield trial.

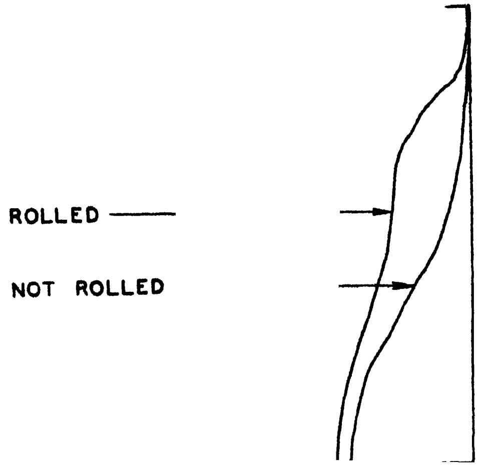

Fig. 6.

26 April 1932. Loam, surface dry when measured, onion seed-bed. Consolidated with a horse-drawn smooth roller. No yield trial.

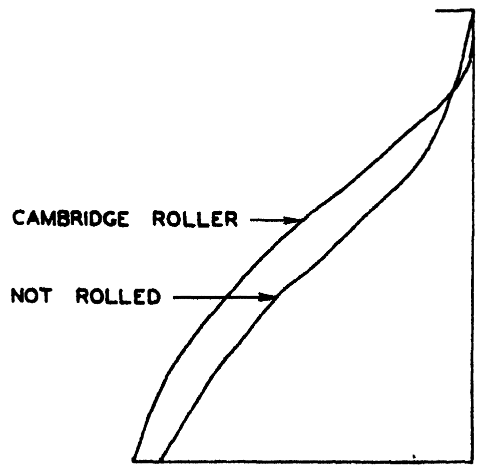

Fig. 7.

13 May 1931. Loam, surface dry, ploughed, tractor disc-harrowed, drilled and harrowed. Consolidated with a horse-drawn cambridge roller. No yield trial.

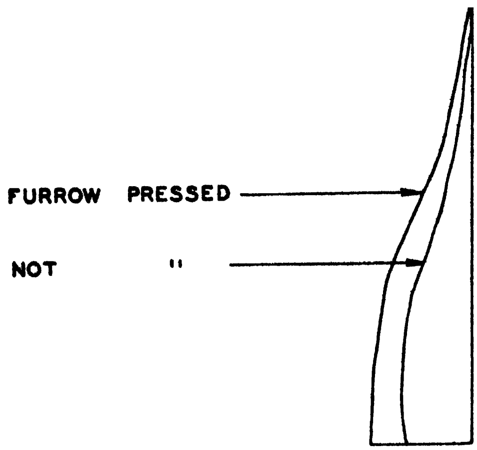

Fig. 8

14 November 1932. Loam, surface moist when measured, ploughed, furrow-pressed, drilled and harrowed. Yield trial proceeding.

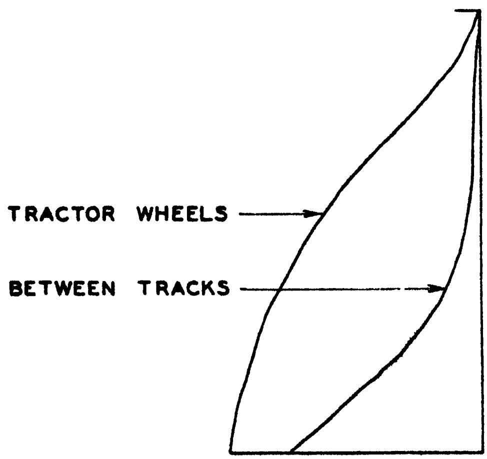

Fig. 9.

28 May 1932. Loam, surface moist, ploughed and cultivated for market garden crops. Curves show the consolidation caused by light tractor wheels, when pulling a transplanting machine, and the consolidation between the tracks It will be seen that the differences between the two curves are greater at 2 to about 4 in. from the surface than deeper down.

Hoof marks caused by horses pulling the consolidating or other implements were avoided as much as possible in taking the above readings.

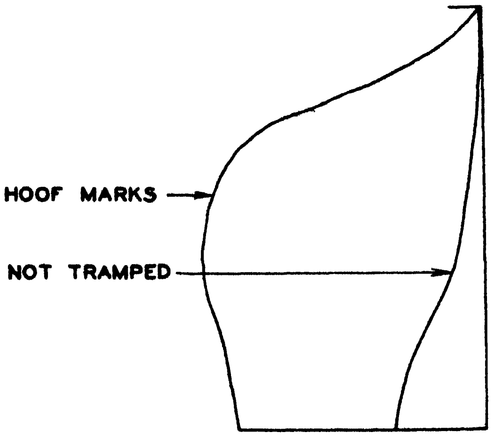

Fig. 10.

3 March 1932. Loam, dry when the soil was packed and the readings taken. Ploughed and cultivated for barley. The hoof marks were made by an average weight draft horse pulling a manure distributor. No yield trial. Here again the packing is greater in the first 3 or 4 in. than deeper down.

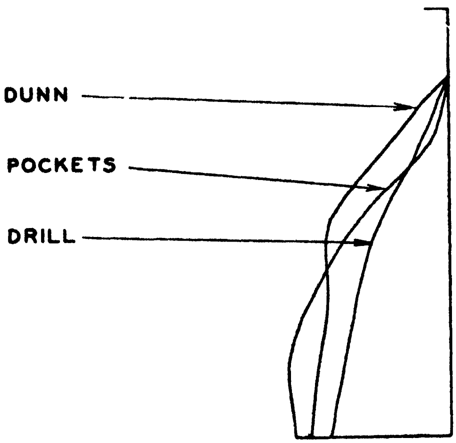

Fig. 11.

12 May 1932. Loam. Readings taken two months after sowing. This was an experimental area upon which were arranged three sets of plots seeded in different ways: viz. (1) Dunn's system, in which the seed was deposited in trenches, 9 in. wide and about ¾ in. deep, which were well firmed by tramping before being sown; (2) the "pocket" system, wherein the seed was set in 3 in. circular depressions made by forcing a suitable former into the soil to a depth of about an inch; and (3) the usual method of sowing with a drill. The yields of grain were:

Dunn.	*Pockets.*	*Drill.*	
31·2	27·1	32·6	cwt. per acre. (2)

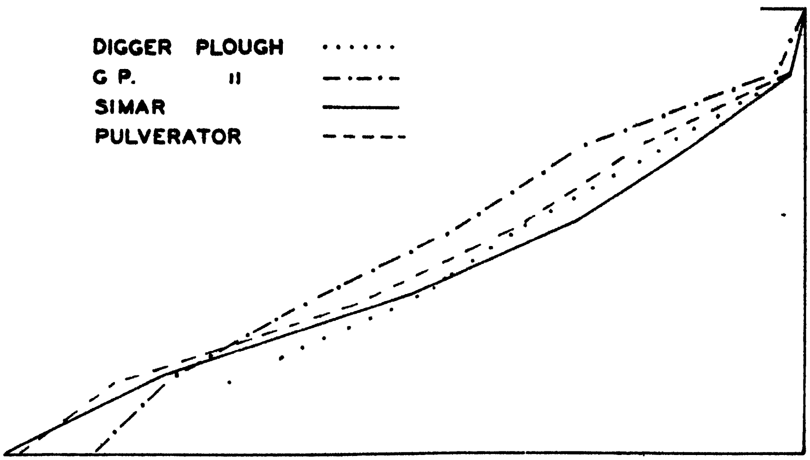

Fig 12

17 July 1931 Loam. These consolidation readings were taken five months after preparing the seed-beds This was also an experimental area upon which the effects on yield of different methods of tilling were studied. The soil was wet when the readings were taken. The yields of grain were : —

General purpose plough.	*Digger plough.*	*Pulverator.*	*Simar.*
24·44	23·64	23·15	21 cwt. per acre. (3)

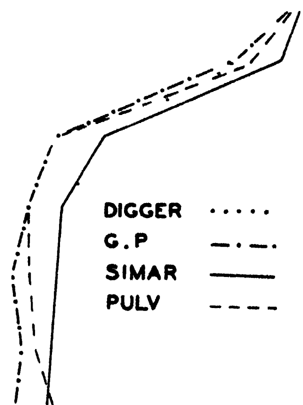

Fig 13.

25 April 1932. The same site as Fig. 12 upon which seeds hay was growing. The consolidation measurements were made fourteen months after the plots were prepared when the soil was very moist. There were no significant differences in hay yield on these plots. (4)

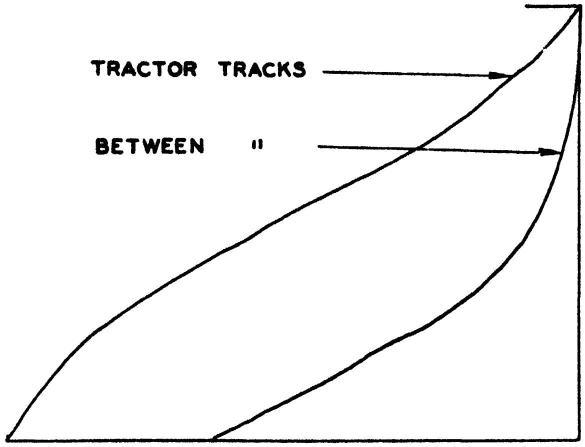

Fig 14

13 May 1931. Loam, ploughed, tractor disc-harrowed and drilled. A stronger growth of the barley crop grown was noticed (5) along the tractor wheel tracks made when disc-harrowing, and the yields were :—

	On the tracks.	*Between the tracks.*
Grain	28·42	16·42 cwt. per acre.
Straw	30	17·02

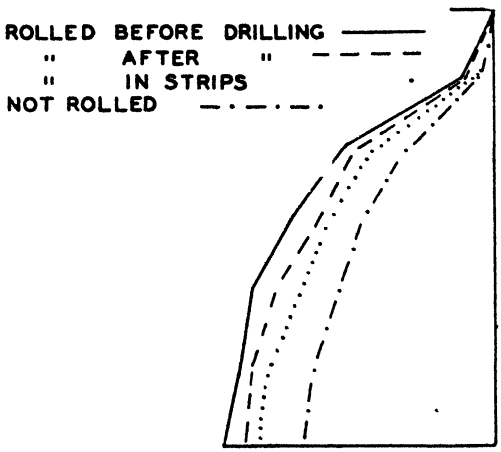

Fig. 15.

27 May 1932. A controlled experiment (6) was made on the same site as Fig. 14, in which consolidation resembling that caused by the tractor was simulated with a special roller. There were no significant differences in the yields of the barley crop which was again grown.

It is not acceptable to compare consolidation produced by any particular implement with that of another if the readings are not taken at the same time and under similar conditions, because variations in moisture content of the soil and other factors cause differences which make them incomparable. For example, readings taken on a well packed, but moist soil might give lower readings than those on a looser, but very dry area. But if sufficient replications are made I am quite satisfied that the compactometer can detect even small differences in consolidation.

In the future it may be that the correct degree of consolidation for any particular soil and crop will be known, but we must understand better the properties of soils and be able to control their composition with greater precision than is now possible before that time arrives, and much evidence must be collected and studied before we can understand even this one problem of consolidation. We intend to pursue our studies and to enlarge them as opportunity occurs.

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(5) Idem, January 1932. *Jour. S.E. Agric. Coll.*, No. 29, p. 57.

(6) Idem, January 1933. *Jour. S.E. Agric. Coll.*, No. 31, p. 67.

THE CONTROL OF APPLE SCAB: ALLINGTON PIPPIN AND NEWTON WONDER, 1932

By W. Goodwin, H. Martin, E. S. Salmon and W. M. Ware.

Since 1927 spraying experiments against Scab have been carried out in one of the apple plantations at the South-Eastern Agricultural College, Wye, Kent. A summary of the excellent results obtained, during the past five years, by the use of home-made Bordeaux mixture was given in the last number of this *Journal* (*Jour. S.E. Agric. Coll.*, No. 30, p. 61 (1932)). It was decided to compare, in the season of 1932, the fungicidal efficiency of home-made Bordeaux mixture with a vegetable oil-Bordeaux emulsion.

There are reasons for belief that this oil-Bordeaux emulsion can safely be applied in a heavy wash on apple foliage, whereas the ordinary Bordeaux mixture must be applied in a fine, misty spray—an operation requiring more time. Further, on chemical grounds, it seems possible that a less amount of copper for fungicidal efficiency will be required in oil-Bordeaux emulsions and that spray injuries may be avoided. Moreover, as vegetable oils have been discovered to be fungicidal against the Hop Powdery-Mildew,* it is probable that a vegetable oil-Bordeaux emulsion may prove to be of value in controlling Apple Powdery-Mildew as well as Scab. In these first trials, mustard oil was used (as described below).

The trees in plot A were sprayed with 8 . 12 · 100 Bordeaux mixture (8 lb. copper sulphate, 12 lb. hydrated lime, 100 gals. water) and, for reasons given in last year's Report, four applications were given, two pre-blossom and two post-blossom. The trees in plot B were used for trials with a vegetable oil-Bordeaux emulsion. A similar wash had been used with success for the control of potato blight in trials described elsewhere in this *Journal* and in which it had been observed that the presence of the oil improved the retention of the copper-containing deposit on the potato foliage to such an extent that a reduction of the initial copper concentration of the wash was considered possible. The vegetable oil used in the present apple-spraying experiments was a crude expressed oil of mustard of high acid value (equivalent to 27·3 gm. oleic acid per 100 ml.), which at a concentration of 1 per cent had been found to control the Hop Powdery-Mildew. The wash was prepared by the addition of a mixture of 1 gal. of oil and 4 gals. of 10 per cent copper sulphate to 95 gals. of water containing 6 lb. hydrated lime. The oil readily emulsified when the mixture was stirred but a green scum of copper and calcium soaps separated which, although not clogging the nozzles during the application of the wash, prevented the use of a strainer in the spray tank. Arsenate of lead paste was added to the sprays in both the pre-blossom applications at the rate of either 6 lb. or 4 lb. per 100 gals. to the Bordeaux mixture and of either 3 lb. or 2 lb. per 100 gals. to the oil-Bordeaux emulsion. Nicotine, at the rate of 8 oz. per 100 gals.† was added to the second pre-blossom and first post-blossom sprays and the trees in the plots unsprayed against Scab were washed with an insecticide containing 6 oz. nicotine, 4 lb. arsenate of lead paste and 6 pints concentrated sulphite lye (60° Tw.) on 18 April, three days before

* See Martin and Salmon. The Fungicidal Properties of certain Spray-fluids, VIII (*Jour. Agric. Science*, XXI, 651 (1931))

† In plot B only, at the first pre-blossom application, 6 oz. nicotine per 100 gals. were used.

the first pre-blossom Scab spray. The same trees were again sprayed with this insecticide, except that 8 oz. of nicotine were used instead of 6 oz. on 6 May, four days before the second pre-blossom Scab spray.

The spraying machine used was small and motor-propelled, with 2-speed gear. It was driven by a 2½ h.p. 2-stroke air-cooled engine which also operated the double barrel, horizontally opposed pump. The tank, of 40 gals. capacity, was mounted on the same chassis and the whole unit, by means of a special steering device, could be turned in its own length. Two 30 feet rubber hoses were attached to the machine and two 8 feet aluminium-alloy lances, each with single " Mistifier Junior " nozzles, were used. The pressure maintained during spraying was about 200 lb. per sq. inch.

The first pre-blossom application was made on 21 April when the nozzles were fitted with No. 1 discs for both sprays. The weather, though sunny at the start, became cloudy and dull with a strong SW. breeze so that the three Newton trees in Control plot 1, adjoining plot A, received drift from the spraying. Later, however, the wind was mainly from the South and little or no drift was carried from plot B into plot A. On plot A, 70 gals. of Bordeaux mixture were used, the time taken being 57 minutes, an average of 2·9 gals. per tree applied in 4·75 man-minutes. On plot B, approximately 100 gals. of the oil-Bordeaux emulsion were applied in 46 minutes, an average of 3·7 gals. and 3·4 man-minutes per tree.

The second pre-blossom application was made on 10 May, under sunny conditions but with a variable wind. A gusty breeze was blowing from the NW. before spraying began ; it became less strong and even calm, changing to West when spraying began and later again gusty from the South and with the sky overcast. Greater attention was paid to the manner of application and a light spraying of the Bordeaux mixture was carried out on plot A, for which the nozzles were fitted with No. 0 discs. Thirty gallons were applied and the time taken was 33 minutes, an average of 1·25 gals. and 2·75 man-minutes per tree. The oil-Bordeaux emulsion was applied with nozzles fitted with No. 1 discs and the trees were drenched. Seventy gallons of the wash were applied and the time taken to spray the plot was thirty-five minutes, an average of 2·6 gals. and 2·6 man-minutes per tree.

For the first post-blossom application, made on 6 June, nozzles fitted with No. 0 discs were again used on plot A. The weather was dull and cool with a strong North breeze. Seventy gallons of Bordeaux mixture were used on the plot which took 90 minutes to spray, an average of 2·9 gals. and 7·5 man-minutes per tree. Nozzles fitted with No. 1 discs were used for the oil-Bordeaux emulsion, the plot receiving 90 gals. of the wash in 85 minutes, an average of 3·3 gals. and 6·3 man-minutes per tree.

For the second post-blossom application on 27 June, nozzles fitted with No. 1 discs were used in both plots. Weather conditions, with sunshine and complete calm, were perfect for spraying. In plot A, 65 gals. of Bordeaux mixture were used, the time taken to spray the plot being 57 minutes, an average of 2·7 gals. and 4·75 man-minutes per tree. On plot B, 80 gals. of the oil-Bordeaux emulsion were applied in 50 minutes, an average of 3·0 gals. and 3·7 man-minutes per tree.

The number of trees in the plots is too small to permit an accurate comparison of the times taken per tree for the light application of Bordeaux mixture and the heavy application of the oil-Bordeaux wash ; the relative merits of the washing and spraying methods of application should be determined on the basis of a number of full-day

sprayings. It is, however, noteworthy that in every case the average time taken per tree with the oil-Bordeaux emulsion is less than that taken with Bordeaux mixture.

On 28 July, for the suppression of Woolly Aphis, the whole plantation was sprayed with a proprietary wash (Katakilla), and for the same purpose on 16 August with a mixture consisting of soft soap 8 lb., nicotine 10 oz., water 100 gals.

On 21 April, immediately before the first spraying, the Allington buds had burst and the young leaves, free from the scales, were still folded or in process of becoming flattened. The blossom buds were hardly visible. The Newton buds were more backward than the Allington ; most of them showed only the tips of the leaves just emerging from the scales but in a few the young leaves were separating and becoming flattened. With both varieties no Scab was found either on young leaves or on the young wood of last season's growth.

An examination of the orchard was made on 10 May, just before the second spraying.

Allington. The buds were in the early pink stage with the colour of the petals only just showing or were even more backward and green with the blossoms not separated in the truss and the petals still covered by the calyx. Around the blossom trusses six to seven leaves were expanded. In the lambourdes six leaves were commonly open and two younger ones were still folded and in the vertical position in the centre of the cluster. Although the state of development of the buds was "pre-pink," it was decided to carry out the second spraying, for the weather had been so cold and wet that the buds had been retarded and it was thought they would expand rapidly with the advent of the first warm weather. In the Bordeaux-sprayed plot (A) no Scab was seen. Most of the leaves round the trusses were spotted, particularly on the lower surface, with minute brown spots due to the first spraying. This injury was slight and no real scorching of the laminae had occurred. A similar slight flecking with small brown spots was occasionally present at the tips of the sepals. The Bordeaux deposit from the first application was plainly visible on the branches but not on any of the leaves. In the oil-Bordeaux plot (B), active Scab pustules were found on a single one-year-old shoot but a blossom truss with young leaves immediately below this source of infection was still healthy and no Scab, other than this which had over-wintered, was found on any tree in the plot. As in plot A, but to a less extent, a slight brown spotting of the blossom truss leaves occurred. In the control plots, the Scab fungus was beginning its attack but was as yet scarce, being found e.g. on only one blossom truss leaf on each of a few trees in all plots. The fungus was dendritic but not powdery or olivaceous ; it was spreading over an area about 9 mm. diameter on the upper surface of the leaf and was difficult to distinguish in this very young and hardly sporulating condition. No brown flecking of the leaves, such as was noticed in the sprayed plots, occurred.

Newton. Blossom buds, which were very scarce on some of the trees, were in a backward state of development. They were still green, with the calyx completely enclosing the petals and were closely clustered in the centre of the rosette of five to six small leaves. Only one or two buds, here and there, showed a trace of the pink colour of the petals. On reference to notes made in 1931, it was found that the trees were showing the phenomenon of blossom production in alternate seasons, all the trees which cropped in that year being now without blossom and vice versa. On the non-blossoming trees, the foliage consisted of the lambourdes with at the most four leaves expanded and the wood-buds with the first few leaves unfolding. In both sprayed plots, Scab was not present and hardly any brown flecking occurred such as was common on the sprayed

Allingtons. In the control plots the disease had not started; over-wintered pustules were however found on a few one-year-old twigs.

The plantation was next inspected on 6 June, before the third (first post-blossom) spraying on that day.

Allington. All except a very few petals had fallen. The new wood had reached a length of 6 to 10 inches with nine to fourteen leaves all of which were healthy though only the two or three lowest ones had been sprayed. In the lambourdes six to eight leaves were expanded and of these only three showed the deposit of the last spraying. In plot A, the sprayed leaves were falling to a slight extent, both from the lambourdes and the blossom trusses as well as from the lower part of the new wood shoots. The fall was readily seen when a branch was lightly shaken. On these sprayed leaves a slight amount of brown flecking and some puckering had been caused but no serious injury. No Scab was found. In plot B, no spray damage was apparent. On rare occasions large areas of Scab were found on the sprayed surface of leaves around the blossom trusses; on the other hand, dried up or killed patches of the fungus here and there occurred, situated in a quantity of the oil-Bordeaux deposit. Establishment of the disease on one of the younger (unsprayed) leaves of a few lambourdes was noticed; these lambourdes were on the axis of the new inflorescence. In the control plots, Scab was present on all the young wood shoots on any leaf up to the third from youngest but it was not so commonly present on the four or five (older) leaves as on those from the sixth upwards, where it had become powdery and very conspicuous. The youngest four of the eight leaves of the lambourdes and dards were often sooty with Scab on the upper surface; these leaves were already large, being about 4 inches by 2 inches. Rather less infection occurred in control plot 1 than in 2 or 3.

In this season, in the Allingtons, the infection was far less on the foliage close in to the branch, being mainly on the younger leaves. Thus the older leaves (around blossom trusses and in lambourdes) were comparatively healthy and the hidden state of the infection with killing of the leaves commented on in former seasons in the Allington variety was not a feature in 1932 (*Jour. S.E. Agric. Coll.*, No. 27, p. 196, 1930; No. 28, pp. 197-8, 1931 and No. 30, p. 29, 1932). Hence it followed that on those trees which had been " ringed " in 1931 and which were covered in 1932 with blossom trusses, there was very little of the Scab fungus. On the trees not " ringed " and on which breastwood and lambourdes were more common, the disease was more prevalent, especially on the younger leaves. The freedom from Scab of the older leaves, e.g. those of the blossom trusses, in the unsprayed plots showed that in this season one or possibly both of the pre-blossom sprayings might have been dispensed with.

Newton. In this variety the blossom had fallen but a few petals remained here and there. The new wood was 6 to 7 inches long with nine to twelve leaves, of which none but the lowest two or even one, had been sprayed. The lambourdes bore six to nine leaves of which only one showed the deposit of the last spraying. As noted above, a portion of the total number of trees had blossomed heavily and in the sprayed plots it was obvious that, had the infection been present, the blossoming trees were better protected than the others, because their branches were covered with blossom trusses with sprayed leaves, whereas the mass of foliage of new wood growth and lambourdes, plentiful on the non-cropping trees, was here absent. Of the fourteen trees in the control plots, three bore a heavy crop of blossom, three a medium and eight a negligible crop. Seven of the twelve trees in plot A bore a heavy, two a medium, and three a negligible

crop. Seven of the fifteen trees in plot B bore a heavy, three a medium, and five a negligible crop.

In plot A, the blossom truss leaves and the oldest leaf of the lambourdes were the only ones showing the deposit of the earlier sprayings. The truss leaves were flecked with small brown spots and a few were falling; this slight injury was attributed to the Bordeaux mixture since it was not found in the unsprayed plots. The trees generally were very healthy but fresh infections by Scab were present, in a very few instances, on the youngest leaf of a lambourde. The foliage on the new wood was all healthy. The attack, though rare on the youngest leaf, with six or eight other unsprayed leaves in the lambourde, indicated that the fungus had been quiescent up to this date. In plot B, infections by Scab were more frequent on each tree than in plot A; they occurred on the lambourde leaves and even on the lower surface of the blossom truss leaves on each tree. The attack, though slight, on the blossom truss leaves, indicated that here at least the pre-blossom sprayings had been needed. One instance was seen, both in this plot and in plot A, of the fungus growing in the deposit of the Bordeaux mixture; the phenomenon has been discussed in a former article (*Jour. S.E. Agric. Coll.*, No. 30, p. 62, 1932). In plot B, as in A, the foliage of the new wood was healthy, again showing that the fungus was quiescent; one shoot with twelve leaves, however, showed Scab nearly covering the laminae of the fourth and fifth leaves from the base. Although some brown flecking of the blossom truss leaves was present in this plot, no leaf fall occurred as in plot A.

The unsprayed Newtons in the control plots showed very little infection of the blossom truss leaves; the six to nine leaves of the lambourdes were also all healthy except perhaps for infection of one or two here and there. Where the Scab occurred, it was present on the younger leaves; on a dard for example, with nine leaves, the sixth and seventh were infected and on a lambourde with six leaves, the fourth and fifth were spotted with Scab which was becoming powdery; another lambourde with nine leaves showed infection on the three youngest. The ten to thirteen leaves on the new wood were commonly all healthy but occasionally the younger ones showed areas of recent infection. On the whole, the unsprayed trees were fairly healthy except for a slight and recent spread of the fungus.

Four days after the third spraying (first post-blossom) a further examination was made and in plot A* a slight leaf fall was occurring from both Newton and Allington trees; the falling leaves were green or yellow-mottled. The action of the spray in causing the fungus to shrivel up was already noticeable although only four days had passed since the spraying had been given.

On 24 June three days before the fourth spraying the plantation was visited.

Allington. The new wood growth was 12 to 17 inches long with thirteen to seventeen leaves of which seven to nine showed the deposit of the last spraying. On certain trees "ringed" in 1931, very few new wood shoots occurred and the foliage consisted almost entirely of fruit truss leaves and lambourdes. The apples, which were slightly smaller on the "ringed" trees, had grown to a diameter of ½ to ¾ inch. In plot A all the leaves on the new wood shoots were healthy. The six to eight leaves of the lambourdes all showed spray deposit and here and there patches of Scab, shrivelled up

* No such leaf fall occurred in plot B, or in the control plots.

by contact with the Bordeaux deposit, were present on the youngest leaf. The radiating lines of the fungus were of purple-red colour and it had evidently been killed. A limited killing also of the leaf tissues close to the lines of the fungus, was distinguishable by means of a pocket lens. A few lambourdes and dards had apparently developed one young leaf since the last spraying. Scab was very rare indeed throughout the plot and nearly all the apples were healthy ; on a branch, however, obviously missed in the last spraying, two apples, for example, were covered with 2 mm. diameter spots and in a few rare instances fruitlets infected on the sepals and elsewhere were about to fall.

In plot B a great amount of leaf infection occurred and the next spraying was evidently required. The fungus present on the older sprayed leaves of lambourdes was not killed unless in contact with, or very close to the deposit of the oil-Bordeaux mixture. There was, furthermore, fresh infection on parts of leaves not covered by the spray both on young wood and lambourdes ; this gave the impression that the fungicide was ineffective at a distance. No appreciable attack was developing as yet on the seven or more young unsprayed leaves of the new wood shoots and, on comparison with those in the control plots, it was plain that the spraying had little connection with this immunity. Scabbed fruits in this plot were rare. Examination of the leaves attacked showed that a spread of infection probably occurred at about the time of the last spraying. The extent of the disease was not yet serious but Scab-infected leaves were present on every branch of each tree. The control plots were heavily attacked but the fungus was not quite so conspicuous as on the Newton trees in the same plots. The foliage of every new wood shoot was infected and many lambourde leaves were powdery with the fungus, the infected areas of the laminae being sometimes killed and brown in colour. On the new wood shoots the youngest seven leaves were commonly healthy whereas a severe attack occurred on the three leaves in the centre of the length and again little or no attack on the leaves towards the base. The four younger leaves of the lambourdes were generally infected and the four older ones healthy. In any lambourde the bases of the petioles of the younger leaves are almost in contact with the bud-scale and when heavily infected lambourde leaves were found in this plot, an inspection of a number of young buds was made in order to discover whether the outer scales might have become infected by spores carried by rain-water down the petioles. One such case of recent scale-infection was found on a bud situated in the centre of a rosette of seven leaves, the petioles of four of which were powdery with Scab. It seemed probable that this recent infection might well give rise in the following spring to the condition recently described* and illustrated for the variety Worcester Pearmain. The apples in this unsprayed plot were here and there spotted but the attack was not yet complete. A general survey gave the impression that infection was plentiful on every branch but, as judged by the freedom from attack exhibited by the younger foliage of the new wood, the dry weather in the month of June was preventing the fungus from spreading further.

Newton. The new wood had reached a length of 8 to 12 inches with ten to fifteen leaves and, in the sprayed plots, six to nine of these showed the deposit of the last spraying. The lambourdes were provided with about eight expanded leaves and the dards with about ten leaves all of which had been sprayed. The largest apples were ⅞ inch in diameter. In plot A the leaves of the new wood shoots, whether covered by the spray or not, were healthy but occasional unsprayed leaves were infected or were showing pale-

* Over-wintered pustules of the Scab fungus were found on fruit bud-scales of the variety Worcester Pearmain, but not on those of Allington Pippin, in May 1931 (*Gard. Chron.*, Vol. 89, 437-8, 6 June 1931 and *Jour. S.E. Agric. Coll.*, No. 30, pp. 40 and 42, July 1932).

coloured areas probably recently infected. On the lambourdes, which were mainly healthy, the youngest sprayed leaf showed here and there a few areas on which the fungus had been killed, an observation which agreed with that made before the third spraying on 6 June. The general impression was that the trees in the plot, including the apples, were very healthy; the fungus where it had occurred had been efficiently killed by the spray. Only rarely was the fungus in an active state on leaves of the new wood which had expanded since the last spraying. In plot B, the foliage of the new wood provided an indication of the progress of the disease, for the three or four leaves last to be sprayed showed the fungus only partly suppressed while the still younger leaves, as yet unsprayed, were already powdery with Scab. An example is provided by a shoot 9 inches long with thirteen leaves of which eight had been sprayed; the lower five leaves were healthy, the sixth, seventh and eighth showed the fungus partly killed but still active, the ninth, tenth and eleventh were also infected and the twelfth and thirteenth as yet apparently healthy. A common feature of the foliage of dards and lambourdes, consisting of about nine sprayed leaves, was the persistence of the fungus in a partly suppressed condition on three or four of the younger sprayed leaves. The fruit truss leaves were still in healthy condition and the apples were not yet attacked. In this plot there was a greater quantity of infection than in plot A and the oil-Bordeaux had suppressed the Scab only where it was in proximity and even then seldom killing it; the dendritic mycelium was quite commonly partly olivaceous and powdery with spores and partly of red-brown colour where it had been killed or it was active and powdery without showing any effect of the spray. The danger at the time lay in the fact that the leaves awaiting the fourth spraying were fast becoming attacked.

In the control plots, the new wood shoots showed infection on most of the leaves, except the four lowest, up to the second from youngest; thus on a shoot with thirteen leaves, the four oldest at the base and the one youngest leaf at the apex were the only healthy ones, the intermediate eight being more or less heavily infected. Of the eight leaves of the lambourdes or dards four were very commonly infected but, here and there, only the youngest was attacked. Some of these leaves were killed and brown and powdery with spores on the surface. Those of the fruit truss leaves which remained were generally healthy; many withered blossoms had failed to set fruit and the apples were scarce. As yet there was little infection of the young fruit. A general survey of the plot showed every tree to be infected, chiefly with spots of ¼ to ½ inch diameter; the attack was developing strongly and infected areas could be distinguished easily even on leaves of the topmost branches. The fungus was present on every lambourde, dard and new wood growth on each tree.

GRADING.

The crop was picked on 10-12 October (Allingtons) and 13-17 October (Newtons). The Allingtons gave 3½ tons and the Newtons 5 tons.

The whole crop was graded by hand, the same method of grading being followed as in previous seasons. Grade I consisted of apples free from Scab*; Grade II of apples on which Scab spots were few or many, but the fruit was not unmarketable; Grade III of apples so cracked or disfigured by Scab as to be unmarketable.

* As many as three very minute Scab spots on an apple (each not larger than the head of a pin) were not considered sufficient to reduce that fruit to the level of Grade II. Such cases were numerically very small.

TABLE I (1932).

Plot and Treatment	Variety	No of Trees	No of Apples picked	Percentage No of Apples in Grades 1	2	3	Weight Apples lb	Percentage Weight of Apples in Grades 1	2	3
A Hydrated Lime Bordeaux mixture 8 12 100 (four times)	Allington Newton	12 12	12,162 16,149	94·1 89·0	5·4 10·7	0 5 0·3	1,996 3,830	93·8 89·3	5·8 10·5	0·4 0·2
B Mustard Oil-Bordeaux emulsion 4 6 100 (four times)	Allington Newton	12 *15	13,802 19,334	83·2 52 9	15·8 45·9	1 0 1 2	2,557 5,153	83·7 54·2	15·4 44·9	0·9 0·9
1. Control (unsprayed)	Allington Newton	3 6	2,957 3,936	29·3 2·0	66 0 83·6	4·7 14 4	591 822	29·4 2·1	67·2 86·4	3·4 11·5
2. Control (unsprayed)	Allington Newton	3 6	4,130 5,086	19·1 4·5	76·7 85·7	4·2 9·8	702 1,181	20·7 4·8	75·9 88·6	3·4 6·6
3. Control (unsprayed)	Allington Newton	6 †2	10,788 2,118	19·4 1·7	74 6 86·8	6·0 11·5	1,925 460	19·9 1·8	75·4 90·2	4·7 8·0
Controls together (unsprayed)	Allington Newton	12 14	17,875 11,140	21·0 3·1	73·6 85·1	5 4 11·8	3,218 2,463	21·8 3·3	74·0 88·2	4·2 8·5

* One of these is a small tree, about 8 feet high

† One of the original three trees was grubbed in the winter of 1931

DISCUSSION OF RESULTS.

ALLINGTON PIPPIN.—The number of Scab-free apples in the three control (unsprayed) plots was 29, 19 and 19 per cent of the crop, giving an average of 21 per cent.

Bordeaux Mixture Plot.—In the plot sprayed four times with Bordeaux mixture 94 per cent of the apples were Scab-free, an increase in percentage of 73 over the average of the unsprayed plots. It may be pointed out here that in the previous experiments on this plot (carried out for five years since 1927) in which each year the trees were sprayed *three* times with Bordeaux mixture, the increase in percentage over the average of the unsprayed plots has been as follows: 1927, 83; 1928, 74; 1929, 64; 1930, 60; 1931, 66. It will be seen, therefore, that although the four Bordeaux sprayings produced a higher percentage of Scab-free apples as compared with that obtained in 1929, 1930 and 1931, with only three sprayings, the percentage was higher in the seasons of 1927 and 1928 when likewise only three Bordeaux sprayings were given. The percentage of Scab-free apples, over the same period, in the three unsprayed plots together were as follows: 1927, 6; 1928, 15; 1929, 23; 1930, 25; 1931, 9.

Mustard Oil-Bordeaux Emulsion Plot.—In the plot sprayed four times with mustard oil-Bordeaux mixture, 89 per cent of the apples were Scab-free, an increase in percentage of 68 over the average of the unsprayed plots. It was noted that the apples in Grade II showed a wide range of Scab-infection; many of the Scab-spots were old, large and "corky," but new, black spots also occurred.

NEWTON WONDER.—The number of Scab-free apples in the three control (unsprayed) plots was 2, 4·5 and 1·7 per cent of the crop in each of those plots or 3 per cent of the crop in those plots taken together. In all the unsprayed plots all the apples in Grade II were badly scabbed with numerous black spots of about ¼ inch diameter, and Grade II was only slightly better than Grade III—the one shading off into the other.

Bordeaux Mixture Plot.—In the plot sprayed four times with Bordeaux mixture 89 per cent of the apples were Scab-free, an increase in percentage of 86 over the average of the unsprayed plots. It may be pointed out here that in the previous experiments on this plot (carried on for five years since 1927) in which each year the trees were sprayed three times with Bordeaux mixture, as high a percentage of Scab-free apples as this had never been obtained, the figures of the increase in percentage over the average of the unsprayed plots having been as follows: 1927, 74; 1928, 70; 1929, 60; 1930, 62; 1931, 50. The percentage of Scab-free apples, over the same period, in the unsprayed plots together were as follows: 1927, 14; 1928, 15; 1929, 13; 1930, 12; 1931, 1.

Mustard Oil-Bordeaux Emulsion Plot.—In the plot sprayed four times with mustard oil-Bordeaux emulsion, 53 per cent of the apples were Scab-free, an increase in percentage of 50 over the average of the unsprayed plots. The comparative failure of the mustard oil-Bordeaux emulsion to control Scab in Newton Wonder as compared with the results obtained with the same wash in the Allington Pippin plot, is discussed below at p. 104.

In our article dealing with previous experiments (*Jour. S.E. Agric. Coll.*, No. 30, p. 61 (1932)) we reached the conclusion that under the conditions obtaining in the plantation at Wye College it would be advantageous in some seasons to give two pre-blossom applications to Newton Wonder instead of only one. In 1932 for the first time, two pre-blossom applications were given and a greater increase in percentage of Scab-free apples

over the unsprayed crop was obtained. Had biological observations not been kept, the error might have been made of attributing this result to the extra early application, whereas, as pointed out above (pp. 98 and 99) the Scab fungus was not in evidence on the unsprayed trees until after the blossoming period.

RUSSETING.

Allington Pippin.—In the plot sprayed with Bordeaux mixture, 356 apples, in Grades I and II were definitely russeted as the result of spraying; this represented 2·9 per cent (by number) of the total crop, and 3·1 per cent (by number) of the apples in Grade I. In the plot sprayed with mustard oil-Bordeaux emulsion, 221 apples in Grade I were russeted, representing 1·6 per cent (by number) of the total crop, and 1·9 per cent (by number) of the apples in Grade I.

Newton Wonder.—In the plot sprayed with Bordeaux mixture, a considerable number (about 10 per cent) of the apples showed a very slight russeting round the eye. The injury was so slight as not to be of commercial importance. Other apples showed the same kind of injury to a greater extent and were graded and counted as being definitely russeted; these apples, 449 in number, occurred in both Grades I and II, and represented 2·8 per cent (by number) of the total crop, and 3·0 per cent (by number) of the apples in Grade I. During the past five years' experiments, russeting to this extent had not been met with; the percentage is, however, so small that it cannot be considered important—in view of the fact that a crop of apples 89 per cent Scab-free was obtained.

In the plot sprayed with mustard oil-Bordeaux emulsion 108 apples, in Grades I and II, were definitely russeted, representing 0·6 per cent (by number) of the total crop and 0·8 per cent of the apples in Grade I—an entirely negligible amount.

To enable a comparison of the fungicidal efficiency of the two treatments, it must be assumed that the biological factors influencing the development of Scab are uniform throughout the sprayed and unsprayed plots. The close agreement of the figure for Scab-infected fruit from the three blocks of unsprayed Newton Wonder apples is evidence of the correctness of this assumption, and the differences in the number of Scab-infested apples from sprayed and unsprayed plots are so large that it is obvious that they are due to spraying. Averaging the graded yields of the three unsprayed plots of Newton Wonder, the number of Scab-free apples is 3·1 per cent of the total unsprayed crop. On the plot sprayed four times with Bordeaux mixture this percentage is 89·0, an increase of 85·9 in the percentage figure, whereas from the plot washed four times with the oil-Bordeaux emulsion the percentage of Scab-free apples was 52·9, an increase in this figure of only 49·8. With the Allington Pippins there is too large a difference in the yields of Scab-free apples from the three unsprayed plots to permit the acceptance of an average figure but it is evident that both treatments have given a marked increase of 50 to 70 in the percentage of Scab-free apples.

It would appear that, whereas the oil-Bordeaux emulsion was as efficient as or only slightly less efficient than Bordeaux mixture in controlling Scab in the Allington Pippins, the control of Scab obtained in the plot of Newton Wonder apples washed with oil-Bordeaux was inferior to that obtained in the plot sprayed with Bordeaux mixture. It is possible that this inferior control is due to biological factors such as differences in the vegetative growth or the previous Scab history of the trees in the two

TABLE II.

	Second pre-blossom, applied 10/5/32.		First post-blossom, applied 6/6/32.			Second post-blossom, applied 27/6/32.			
	mg. Cu/sq.m. leaf surface.		mg. Cu/sq.m. leaf surface.		Surface area of 50 leaves, sq.m.	mg. Cu/sq.m. leaf surface.			Surface area of 50 leaves, sq.m.
	13/5	2/6	7/6	20/6	20/6	30/6	15/7	19/8	29/7
Plot A. Bordeaux mixture:									
Newton Wonder ..	80 —	19 21	136 132	99 99	0·35 0·30 0·32	247 226	203 —	145 177	0·38 0·35
Allington Pippin ..	97 109	46 43	136 156	124 132	0·28 0·27 0·24	230 247	186 212	159 159	0·29 0·27
Plot B. Oil-Bordeaux:									
Newton Wonder ..	101 109	36 39	72 74	60 50	0·45 0·38 0·34	141 115	115 80	88 —	0·44 0·41
Allington Pippin ..	88 —	46 46	72 70	53 66	0·30 0·32 0·34	141 141	124 113	103 89	0·34 0·33

plots, but it is more probable that it is due to the inferior fungicidal efficiency of the oil-Bordeaux emulsion.

It is now generally accepted that the fungicidal action of Bordeaux mixture is due to the formation of small but toxic quantities of soluble copper by various agencies from the Bordeaux deposit and, accordingly, the fungicidal efficiency of the spray will be dependent, firstly, on factors concerned in the formation of soluble copper and, secondly, on factors concerned in the retention of the Bordeaux deposit on the sprayed foliage. The influence of the presence of the oil on the latter set of factors was examined by the periodic determination of the amount of copper remaining on the sprayed foliage by a method described elsewhere (Martin, H., *Ann. Appl. Biol.*, XX, 342 (1933)). The results of duplicate estimations are recorded in Table II, in which the amount of copper retained is expressed as milligram per square metre of upper leaf surface. Since this figure would be modified by the growth of the leaves subsequent to spraying, estimates were also made of the total upper leaf surface area of fifty leaves selected at random from trees in the two plots.

The statistical analysis of the figures determined for the surface area of the leaf samples is summarized in Table III. It reveals that whereas the estimates show no significant increase due to the growth of the leaves between 20 June and 29 July, there is a significant difference shown in both varieties in the average surface area of leaves from the two plots, for "z" exceeds 0·8606, the figure appropriate for $P=0{\cdot}05$. The greater surface area of leaves from plot B is more likely to be due to biological differences than to spray treatment. Since no important increase in leaf area occurred, a modification of the figures for the amount of copper retained is unnecessary. The figures show that, on every occasion after blossoming the amount of copper present is greater on the leaves sprayed with Bordeaux mixture and it is probable that the better control of Scab given by Bordeaux mixture on the Newton Wonder apples is related to the greater amount of copper present. The retention of the spray deposit does not appear to have been improved by the presence of the oil to the same extent as was found in trials on potato foliage, but in the latter case, the oil used was a cheap edible grade of cotton-seed oil of low acid value and the amount of copper-calcium soap formed was negligible. It may be suggested on this basis, that a better protective fungicidal action would have been obtained if the formation of copper soaps had been avoided in the preparation of the oil-Bordeaux emulsion.

TABLE III.

Variance due to	Newton Wonder.			Allington Pippin.		
	Degrees of Freedom.	Variance σ^2	$\frac{1}{2}\log_e\sigma^2$	Degrees of Freedom.	Variance σ^2	$\frac{1}{2}\log_e\sigma^2$
Plots	1	90	2·2499	1	78·4	2·1809
Dates	1	28·7	1·6696	1	5·78	0·8772
Error	7	11·2	1·1999	7	2·78	0·5112
		"z"=1·0500			"z"=1·6697	

Our thanks are due to Messrs. J. & J. Colman, Ltd., of Norwich, for a supply of crude expressed oil of mustard and to Messrs. Holder-Harriden, Ltd., for the loan of an "Autofix" motor sprayer.

SUMMARY.

1. Trees of Allington Pippin sprayed four times with home-made Bordeaux mixture applications pre-blossom and two, post-blossom, gave 6 per cent of Scab-affected apples; sprayed similarly with mustard oil-Bordeaux emulsion 17 per cent of Scab-affected apples. In the three control (unsprayed) plots the percentages of Scab-affected apples were 71, 81 and 81.

2. Trees of Newton Wonder sprayed four times with home-made Bordeaux mixture gave 11 per cent of Scab-affected apples; sprayed similarly with mustard oil-Bordeaux emulsion, 47 per cent of Scab-affected apples. In the three control (unsprayed) plots the percentages of Scab-affected apples were 98, 96 and 98.

3. The biological observations made in the plantation from time to time indicated that attacks of the disease were late in the season. For this reason the extra pre-blossom spraying, given for the first time in 1932, cannot alone be credited with having brought about the improvement in health of the crop in Newton Wonder.

4. Uncontrolled differences in the biological condition and previous Scab history of the trees in the two plots make a comparison of the fungicidal efficiencies of Bordeaux mixture and the oil-Bordeaux emulsion almost valueless. It is, however, noteworthy that the greater Scab infection in the oil-Bordeaux plot is associated with smaller amounts of copper found to be retained on the foliage.

THE DOWNY MILDEW OF THE HOP IN 1932

By Prof. E. S. Salmon and W. M. Ware, M.Sc.

In the attacks of Downy Mildew which now take place annually in our hop gardens, very different features present themselves from season to season.* The year 1932 was memorable (1) for the severity of attack on the crown of the hill (noticeable in winter) and on the bine in early summer and (2) for the check given later to the disease by the hot weather.

Infection of the Rootstock.

At cutting time we received many complaints of the presence of Downy Mildew in the hill and a few instances may be given here. In February 1932, a grower sent specimens from a Bramling garden at Goudhurst, Kent. This garden had been severely attacked by Downy Mildew during the growing season in 1931 and the diseased crop, together with the bine, had been cut down and burned. The strap cuts sent were brown in the cortex and several of their buds showed brown marks internally. The spawn (mycelium) of Downy Mildew was found in the cortical tissue and in buds which were white inside as well as in those which were brown-flecked. A small piece of an old hill was also sent and the spawn of Downy Mildew was found in tissues of the rootstock at a depth of one and a half inches below the surface.†

A similar case occurred in a hop garden near Wye. On inspecting the garden (Bramlings and Cobbs) in February 1932, it could be seen at once that the strap cuts were seriously affected ; some hills when cut were so brown that there appeared little hope of their producing enough shoots for the season's growth. Many hills thus affected had been grubbed—some 400 to 500 hills in 9 acres of Bramlings had been removed during the winter. A Fuggles garden adjoining was not affected. On microscopical examination mycelium was found in all the strap cuts collected ; some of these were blackened and becoming soft and rotten, probably due to the attacks by the Downy Mildew, since its mycelium was present in quantity. Several of the worst-affected hills (rootstocks) were removed and sectioned and examined microscopically, and the Downy Mildew mycelium was found to be deep-seated in the tissues; it was found also in roots of 1 inch in diameter and in smaller roots to a distance of 6 inches away from the origin of the root. There could be no doubt that in this garden the Downy Mildew was actually killing the hills and roots. This is the first case of the kind, we believe, to be recorded for this country.‡

In another instance, where a garden of Tutshams near Faversham was inspected in March, the straps were brown when cut and several hills were partly or completely

* A reference to previous articles published will be found in *Jour. Inst. Brewing*, XXXVIII, 37, Jan. 1932, and in the leaflet, *The Hop Downy Mildew and its Control*, p. 15, Feb. 1931, S.E. Agric. Coll., Wye, Kent.

† The grower was inclined to grub the garden if the presence of Downy Mildew in the rootstock was ascertained. We were able to assure him, however, that provided the bines were properly sprayed with Bordeaux mixture, there was no reason why a healthy crop of hops should not be grown.

‡ In 1926 Riols recorded the death of hop hills, up to 30 per cent, in certain gardens in France (*Rev. Path. vég.*, XIII, 282 (1926)).

decayed. Portions of such hills, when examined, were found to be invaded by mycelium of Downy Mildew which was probably the cause of the rotting. It was noticeable that the hills were worse affected in certain areas where the crop had been turned brown by the disease in 1931 and had not been picked.

In May we received from a garden near Canterbury a nearly dead hop hill bearing only one weak shoot, 4 inches long. The rootstock was 3 inches thick and 6 inches deep before the main roots branched out; Downy Mildew spawn was found in the "crown" and extended to the full depth of 6 inches of the rootstock. It was also present in the first 2 inches of one main root.

It is evident from the cases given above that the attack by the Downy Mildew on the rootstock may reach a dangerous intensity. It is to be hoped that where regular spraying with Bordeaux mixture is practised, the hill will be enabled to remain at any rate sufficiently sound to produce each year shoots of the necessary vigour. Under the conditions at present obtaining in hop nursery beds (where it is not uncommon to find young plants full of "spikes"), it is unfortunately only too probable that new hop gardens are planted up with already seriously diseased plants.

Experiments on the Treatment of the Hill.

In the spring of 1932 experiments were made to determine whether it might be possible to reduce the large number of basal spikes produced from the hill as a result of the disease. In 1929 it had been shown (*Ann. Bot.*, XLIII, 683 (1929)) from inoculation experiments carried out in the previous spring, that basal spikes could be produced from infected buds on the crown. In this case the buds on the crown had been artificially infected by placing on them swimming-spores (zoospores) of the fungus. Now, assuming that under the conditions of an ordinary hop garden some few basal spikes are bound to appear, it is obvious that these, being situated immediately over the crown of the hill, are in the best possible position for shedding spores on to the soil or directly on to the crown. Here, as is equally obvious, infection of some of the numerous buds of the crown will take place and from these a later crop of basal spikes will arise. Ever since this point has been realized, not only thorough but also prompt removal of basal spikes has been advocated. In addition, it had been shown (*Jour. Agri. Sci.*, XIX, 185 (1929)) by experiments made in 1928 that in the swimming-spore (zoospore) stage the fungus was exceptionally vulnerable; the zoospores could be killed by the merest trace of certain chemicals. The present experiments, therefore, were designed to place directly on the crown of the hill or on the soil above it, a deposit of some substance toxic to the spores so that all shoots from the crown would have to grow through the chemical applied. If any of these shoots developed into spikes, the black spore-deposit on the leaves would be rendered more or less innocuous since all spores would be shed on to chemically-treated soil and infection of buds should, in theory, become impossible.

On 1 February, when the hills had been dressed ("cut") and were still exposed, 368 hills were sprayed with 1 per cent Bordeaux mixture on the cut surface and some of the spray was also applied to the surrounding soil in a circle of about 10 inches diameter. A 3 gallon pneumatic knapsack sprayer was used and one filling was sufficient for forty-eight hills.* The sprayed hills were in two rows of the hop nursery-garden at Wye College

* We are informed by a grower who used this method in 1931 that, in commercial practice, 20 gals. were used per acre. This, with 900 hills per acre, represents forty-five hills treated with each gallon, or about one-third the quantity of spray per hill used in our experiment.

and three alternate rows were left untreated ; all were later covered in with earth on the day the spraying was done. During the month of May all basal spikes were collected and counted on four occasions, the last being on 28 May. The counts were continued up to 8 June, but these later spiked growths were not taken into account because of the possibility that some might be nothing more than short terminal spikes about 1 foot high and caused by infection taking place above ground. By limiting the counts to the month of May, it was ensured as far as possible that only the shorter basal spikes were included and though it would be impossible to show that these shoots had not become " spiked " *after* emerging from the ground, it was thought most likely that they had come through the soil in the already infected condition. This limitation of the counts to the month of May applies not only to the experiment above described, but also to all of those which follow. From the 368 hills sprayed with Bordeaux mixture, 318 basal spikes were collected, i.e. 86 spikes from every 100 hills. From the 524 untreated hills in the alternate rows, 576 spikes were collected, i.e. 110 spikes from every 100 hills.

In another experiment, on 18 February 1932, when the hills had been dressed and were still exposed, 163 hills in one row were dusted with 6 lb. of a dry proprietary copper-lime dust which was applied by means of a knapsack dusting-machine, the powder being applied also within 1 foot radius of each hill. On the same day a further 163 hills in another row were treated with 15 lb. of the same dust which was thrown on the cut rootstocks from a scoop, approximately 1½ oz. per hill being used. As controls, 407 hills in the three alternating rows were left untreated. Counts made to 25 May of all basal spikes showed 72 in the lightly dusted row, i.e. 118 per 100 hills, 31 in the heavily dusted row, i.e. 51 per 100 hills, and 377 in the three untreated rows, i.e. 93 per 100 hills.

A hop grower near Faversham also carried out an experiment using a proprietary copper-lime dust which was applied at the rate of about ½ oz. per hill on 23 April at the time when the shoots were coming through the soil. Eighteen rows (1,548 hills) were treated in pairs and eighteen adjoining rows in pairs were left untreated. The varieties were Cobbs, Mathon, Bramling, and Eastwell Golding. Up to 31 May the basal spikes collected from the treated hills numbered 367 and from the untreated 437.

On 21 April, in three rows of hops in Wye College hop garden, 296 hills were dusted with copper-lime dust on the earth covering the hills. At that time the shoots were 3-4 inches high and the first spikes were becoming distinguishable ; a few of the longer shoots were 9 inches high ; 3-4 oz. of dust were applied by means of a scoop to each hill (i.e. 225 lb.-300 lb. per statute acre). Up to the end of May, 185 spikes had been counted, i.e. 63 per 100 hills, while from 285 untreated hills in three rows adjoining, 172 spikes were counted, i.e. 60 spikes per 100 hills.

On 22 April, 307 hills in three rows in the same gardens were dusted with hydrated lime only, 3-4 oz. of lime being placed on the earth covering the hills as well as on all growing shoots. Up to the end of May, 293 spikes were counted, i.e. 95 spikes per 100 hills. From 318 untreated hills in adjoining rows, 327 spikes were collected, i.e. 103 spikes per 100 hills.

Consideration of all the experiments carried out in 1932 provides little hope of reducing the number of basal spikes with moderate amounts of the materials used. In one case, however, when as much as 1½ oz. of copper-lime dust was applied to the cut rootstocks (i.e. 110 lb. per statute acre) a reduction from 93 to 51 spikes per 100 hills appears to have resulted. In the first place, the experiments must be repeated in order to be sure that any beneficial results are not accidental and in the second place, the

amounts of the powder used are very considerable (up to 300 lb. per statute acre of 1,200 hills) and it is questionable whether the results would repay the heavy outlay in material.

Although, in theory, a chemical deposit on the surface of the earth should prevent penetration of the soil by zoospores, it was found that in practice the chemicals applied tended to form a cake or crust which was very soon cracked or broken up when cultivation of the hop garden was started.

Seasonal Course of the Disease.

The first " basal spikes " were received on 16 April, from a garden of Cobbs in the Sittingbourne district. By the beginning of May basal spikes, often greyish-black through production of spores, were of common occurrence and were received from Herefordshire as well as from Kent. By 19 May the mildew was observed to be actively spreading to the leaves of healthy bines, the characteristic " angular spots " of the secondary infections being found at this date.

Some idea of the number of basal spikes that may be produced is to be gathered from the following figures, supplied by Mr. A. H. Burgess. The garden concerned (Wye Field, Wye College) consists of approximately 2 acres each of Early Birds, Cobbs and Canterbury Goldings. The number of basal spikes removed from each variety during the period 29 April to 31 May was as follows: Early Bird, 4,250; Cobbs, 2,577; Canterbury Golding, 11,456.

From May onwards the occurrence of " terminal spikes " became general in hop gardens and was on an epidemic scale in many districts. The Midland hop yards suffered severely, and we received at this period more enquiries and examples from Worcestershire and Herefordshire than from the other hop growing counties—due largely, no doubt, to the fact that the disease is of more recent occurrence and less well known in the former counties. The following communication is characteristic of a large number received.

A grower from near Hereford wrote: " Directly I saw my hop yards last Saturday (14 May) I noticed these spikes; on that day I could not find any spores but on 16 May, when the spikes I sent you were picked, I found the spores. I have never found these spikes in previous years. I washed the crowns of my roots with Bordeaux after cutting this spring and had every cutting in the hop yard picked up and burned. I have already had my hop yards twice gone over for spikes which are put in bags and burnt with the bags. The disease appears to be worse on Amos's Early Bird than on the Bramling, and the Mathon is slightly attacked. We can find no sign of it on the Fuggle so far."

On a farm near Marden, Kent, visited on 24 May, the Fuggle hop bine was about 3 feet high; basal spikes were present in the bush of shoots from the crown and infection of the tips of the bine, i.e. the formation of terminal spikes, had already occurred here and there.

In visits paid to Kentish hop gardens in the latter part of May it was noted that in some, where cultivations had been neglected, numerous spikes had appeared, towards the centre of the alleys, arising from the old strap cuts and runners which had been thrown out and which were now pushing through the undisturbed soil. Many of these spikes constituted a prolific source of infection, since the lower surface of their leaves was black with spores. It was noticeable, too, that where bine that had not been

trained up was trailing on the ground, the tips were frequently becoming infected and developing terminal spikes.

By 1 June, in Kentish hop gardens, the mildew had begun to spread to the upper leaves of the bine to an alarming extent, large pale spots on the upper surface appearing on leaves above the height to which it was considered safe to strip the bine. To take one instance, in the Wye Field hop garden (where "spiking" had systematically been carried out) infected leaves occurred generally to a considerable height up the bine, most bines having only the three uppermost pairs of leaves healthy. As it was

Downy Mildew attack on the bine at Horsmonden, Kent, 17 June 1932

FIG 1—Left Part of a 7-acre Bramling garden Right Part of a 7-acre Fuggle garden The regularity and the height of the Fuggle bine down to the far end of the roadway form a contrast with the irregularity and spiked condition of the Bramling bine

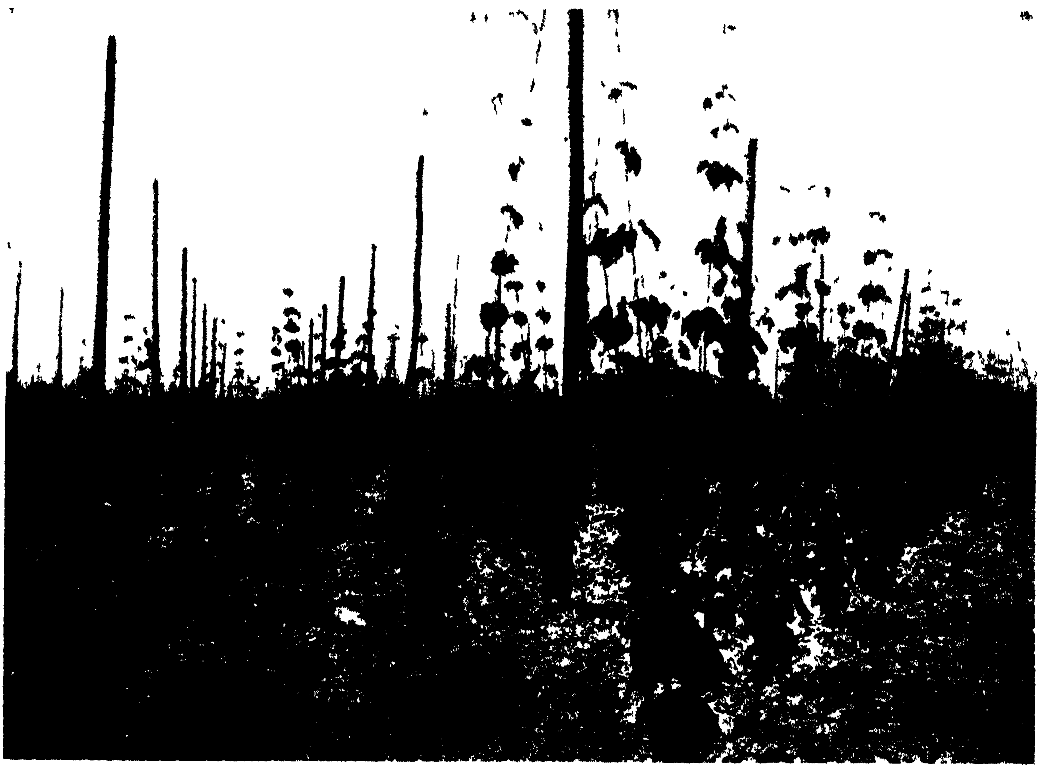
The arrow marks the same hill in both illustrations

considered impossible to strip to the necessary height to remove the disease, an early spraying with Bordeaux mixture of the strength 8 12 100 was given.

The Midland hop yards also suffered extensively. On 2 June a grower from Tenbury wrote "Where my Fuggles join the Mathons, I am rather badly infected. Mathons and Bramlings are full of the plague. We are going through them, removing terminal spikes, twice a week and there is as yet no sign of abatement." Mr. C. E. Pearson, Inspector of the Ministry of Agriculture, wrote from the Midlands hop-growing district: "Some of our growers who did not spray last year are very badly infected with

Downy Mildew, a few finding it difficult to furnish the strings." On 13 June a grower from near Hereford reported that terminal spikes were developing to such an extent in his Goldings (notwithstanding their removal as soon as noted) that he had decided he must apply Bordeaux, although the bine was barely three-quarters up the string.

On 7 June we visited gardens at Teynham, Kent, where notwithstanding the regular and careful " spiking " operations that had been carried out, the disease had started to spread from leaf to leaf on the bine, and " spotted " leaves were common at 1 to 1½ feet from the ground, and exceptionally as high as 3 feet. Stumpy lateral spikes



Downy Mildew attack on the bine at Horsmonden, Kent, 17 June 1932

FIG 2—A view of the same garden, showing in the right foreground the first two rows of the Fuggle variety, the roadway (Fig 1) marked with dotted lines and, beyond this, the Bramling garden with spiked and irregular bine

The arrow marks the same hill in both illustrations

were to be found on the bine below the breast-wire. The presence in unusual numbers of lateral spikes low down on the bine—sometimes on bines that had been stripped—was a notable feature of the season's attacks.

Fuggle bine in many districts suffered in the same way as that of other varieties; a grower from Staplehurst, Kent, wrote on 13 June: " My hops are all Fuggles and I have a lot of ' spiked heads ' now the bine is round about the girth string and the number keeps increasing." A garden of Fuggle, near Linton, Kent, visited on 15 June was similarly infected. On 21 June a grower from near Maidstone wrote: " In my Fuggle

gardens the spikes are at 4 feet. . . . Generally speaking the damage done by Downy Mildew in the neighbourhood is far in excess of any year so far—whole gardens look to be decimated."

At Horsmonden, Kent, on 17 June, 42 acres of Fuggles and 7 acres of Bramlings were visited at the request of the grower. Terminal spikes were in evidence in the Fuggles though not as yet in very great numbers; they occurred at a height of 5 or 6 feet from the ground and it was reported that they had first appeared only four or five days previously. They were in process of being removed. The healthy Fuggle bine was at a height of about 9 feet. The Bramlings formed one half of a 14 acre garden, the 7 acres of Fuggles being separated by a wide alley. In the Bramlings the spiked bines were numerous, nearly every one being attacked throughout the garden and spiked at a height of about 3 feet. Not only these but shoots from the crowns of the hills and lateral shoots were also spiked so that the whole 7 acres presented a very diseased appearance and the garden was not considered worth any serious attempts to save it. Across the wide alley separating the Bramlings from the Fuggles, the outermost row of Fuggles showed rather more terminal spikes than the rest, but nowhere was the attack on this variety so severe as on the Bramlings. The photographs reproduced in Figs. 1 and 2 show on the left the spiked and irregular bine in the Bramlings and, on the right, rows of the Fuggle variety.

Similar devastation to that recorded above was being caused in the Midland hop yards. On 17 June a correspondent from Ledbury wrote: "Especially in the Bramlings, to almost the same degree in Mathons and in some cases in Fuggle yards, the disease has assumed enormously increased proportions. Several Bramling yards have now had the string pulled out from them and the roots are being ploughed up. The majority of growers are seriously alarmed as to whether all the shoots will have acquired spiked heads before they have reached the top wires."

At the end of June reports were received of two gardens (Bramlings) near Faversham and near Maidstone which had been grubbed up owing to the severity of the disease. In East Kent at this date many of the gardens were so short of bine, owing to the removal of those which had become spiked, that only one bine to each string was left.

It will be convenient to summarize here the course the disease had taken so far, as somewhat unusual features had been present. At the beginning of the season, the prevalence of basal spikes was noteworthy. In a few localities the next event was the appearance on the leaves of large spots with spores on their lower surface. At about the same time, particularly following rain and gales of wind which blew the tips of the bine from the strings, terminal spikes became very common just above the breast-wire. The weather in June became dry, sunny and hot; it was very noticeable that under these conditions the brown angular spot stage on the leaves was completely suppressed. Lateral spikes, 1 to 3 inches long, were common at nodes between the breast-wire and bar-string; these were probably caused by external infections at about the same time as or later than the mass of terminal spikes evident about the end of May. The subtending leaves at the nodes where lateral spikes were present were also usually invaded via the petioles and the fungus was breaking out and forming spores in black lines adjoining the main veins. The dry weather of June provided some chance of dealing with the terminal and lateral spikes and with the basal spikes which appeared before and after earthing up.

With the warm dry weather of the first three weeks of July the disease came to an absolute standstill as regards any further spread on the bine, and the fungus in most

(but not all) of the spikes which were still not removed died out. Heavy rains fell at the end of July and by 25 July the angular spot fruiting stage of the fungus could be found on the leaves of "runners." In the dry hot weather of August the disease made little headway, but when the weather changed at the end of the month and heavy rain storms occurred, the disease could be found here and there in the gardens. Although the rainfall was low in August, the prevalence of wet early morning mists in many districts was directly favourable to the disease; for instance, in Wye, on the mornings of 10, 16 and 17 August the leaves of the bines were still dripping wet with mist as late as 10 o'clock.

Hop picking started early on 26 August in some districts and became general by 30 August. Although, speaking generally, the crop of 1932 was picked entirely free from Downy Mildew, there was evidence of the presence of the disease, though usually to a negligible extent, in some gardens.

Affected specimens sent in by growers consisted usually of very small, or even rudimentary, brown cones, which were occurring in small numbers scattered through the gardens. Such hops had evidently been attacked when just coming out of burr, but any general attack had been prevented either by the hot dry weather or by the spraying that had been done. The occurrence of these few, dark-brown rudimentary cones in a crop of otherwise perfectly healthy, fully grown-out and healthy-coloured hops was a remarkable feature of the season.

CONTROL MEASURES.

Control measures against Downy Mildew were carried out with great care by the majority of growers. It was computed that in East Kent at least 80 per cent of the gardens were thus protected. The necessary control measures, which consist of the timely removal of all spikes, followed by spraying with home-made Bordeaux mixture, have been described recently in a leaflet* issued by Wye College and need not, therefore, be enumerated. Some growers, alarmed by the unusually large number of terminal spikes which appeared in June and threatened with a shortage of bine, gave one or two extra sprayings before the bine had reached the top; the majority, however, relied on three thorough sprayings, the first when the bine had reached the top; the second, immediately before or while the hops were in burr; the third, immediately the burr had set. Where care had been taken to remove terminal and lateral spikes, complete control was secured and the crop was picked entirely free from Downy Mildew. The earlier sprayings (before the bine had reached the top) resulted in slight or severe scorching of the young leaves but without any subsequent deleterious effect. It is proposed to carry out experiments to ascertain whether Bordeaux mixture at a weaker strength will control the disease without causing scorching of the leaves at this stage of the growth of the bine. During the past season the fact was again demonstrated that applications of Bordeaux mixture when the hops are in burr, cause no injury whatever to the crop.

Although the hot dry weather of the past season undoubtedly helped a great deal to suppress the spread of Downy Mildew and keep the cones from becoming discoloured, observations showed that the disease was present among or near the cones in many gardens in the form of spikes, which had the weather turned wet before or during picking,

* *The Hop Downy Mildew and its Control*, 15 pp., South-Eastern Agricultural College, Wye, Kent, February 1931.

and had no spraying been done, would have spread the disease to the cones and caused the serious loss met with in previous seasons.

The satisfactory results obtained by growers who took up spraying in 1932, after seeing the damage caused to the crop by Downy Mildew in 1931, may be gauged by the following extract from one letter (from a Hampshire hop grower) among a number received: " In 1931 I had one hop garden, a part of which was Fuggles and a part Cobb's Goldings. I started ' spiking ' and continued to do so until it became useless any longer to spike the Cobb's, intending to wash them with Bordeaux about the middle of June, when the bines should have been at the top of the strings, but they were quite hopeless. I intended to grub the Cobb's but decided to leave an acre or rather more as an experiment, which I did. I did not pull the strings down, no hops were picked (in 1931) and there was very little bine which I just pulled off the strings. In 1932 they had practically no manure, not wishing to grow much bine; many hills were either killed or were very weak owing to the severe attack in 1931. They were washed six times with Bordeaux: first time, a few days after opening and cutting; second, immediately after putting to the strings; third, just after reaching the middle wire; fourth, when the bine reached the top wire; fifth, just as the burr was appearing; sixth, just as they were coming into hop. I picked over 21 cwt. to the acre of good sound hops."

A grower from the Teme Valley, Worcestershire, reported: " Spikes of Downy Mildew appeared in great numbers with the first growth of the hop after cutting and continued to be general until the cones formed. Spiking was systematically carried out from the first appearance of the spikes and we generally got round three times in a fortnight. There was never a time throughout the growing period when spiking was not necessary. We Bordeaux'd three times exactly as recommended by Wye College. The Fuggles were particularly free throughout the season. The Early Birds were by far the most contaminated. The Brewers who purchased our hops reported that they were quite free from copper. We picked a clean crop throughout."

WEATHER IN RELATION TO THE DISEASE.

Since the beginning of our observations upon Downy Mildew, reference has been made to the close association which exists between the weather (notably the rainfall) and the nature of the course taken by the disease. In 1932, hop growers were undoubtedly favoured by the long periods without rain; these are indicated in Table I where, in the months of June and August, it is recorded that the rainfall at Wye, Kent, was 0·8 inch and 1·1 inch below the normal for SE. England. Although in the month of July, the normal rainfall was exceeded by 1·8 inch, most of the rain fell in the last week of the month, nearly 2 inches having been measured on one day only, i.e. 25 July. In April and May, as recorded in the Table, the rainfall was above the normal and of the sixty-one days in those months, no less than fifty were rainy. This fact, coupled with the prevalence of high winds, explains the very general occurrence of terminal and lateral spikes and the opposite type of weather in June, July and August with thirty-five rainy days (twenty-six appreciably wet) out of ninety-two explains why the spread of the Downy Mildew was checked. Consideration of the rainfall alone, however, is insufficient because a high humidity with precipitation, provided there are breezes to carry the spores, is sufficient for germination of those spores and, as has been mentioned, such conditions with heavy mists did actually occur.

In connection with this it is of interest to consider the efficiency of Bordeaux mixture in protecting the ripe cones (a) in wet rainy weather and (b) in misty or dewy

TABLE I.

Rainfall at Wye,‡ Kent, in Relation to Hop Downy Mildew.

		1 Wye, Kent. No of days on which rain fell.*					2 Wye, Kent No. of days on which 0·01 inch or more of rain fell.					3 Wye, Kent. Total Rainfall in inches.					4 Wye, Kent. Deviation from normal of S.E. England. Inches.	5 S.E. England. Normal mean rainfall.† Inches.
Month.	Days.	1928.	1929.	1930.	1931.	1932.	1928	1929.	1930.	1931.	1932.	1928.	1929	1930.	1931.	1932.	1932.	
April ..	30	19	15	17	21	26	15	11	15	17	23	2·56	1·29	1·69	3·59	2·51	+0·82	1·69
May ..	31	17	12	19	18	24	16	7	16	12	19	2·93	1·38	3·93	2·07	2·80	+1·03	1·77
June ..	30	17	15	11	14	8	10	12	5	9	6	2·08	1·81	1·12	0·80	1·08	—0·81	1·89
July ..	31	6	11	21	20	16	6	8	18	14	12	0·93	0·90	2·64	2·79	4·00	+1·83	2·17
Aug. ..	31	19	10	19	25	11	17	7	13	19	8	1·91	2·15	3·04	3·06	1·19	—1·13	2·32
Sept. ..	30	8	5	25	19	24	3	3	21	12	18	0·57	1·19	4·60	1·75	2·42	+0·29	2·13

* Including those days on which a fall of rain was actually observed, but the amount was too small to be measured, i.e. less than 0·01 inch.

† Derived from weekly normals for SE. districts (1881-1915). The meteorological station at Wye has not been long established.

‡ The figures for Wye are derived from the reports of the Meteorological Office of the Air Ministry. We are indebted to Capt. A. H. Bird, in charge of the observations at Wye, for this information.

weather. Assuming that considerable quantities of the spray deposit have been lodged on the leaves in the "heads" well up above the top wire, any spores of the fungus reaching the unsprayed cones in rainy weather are forced to attempt their germination process in water contaminated with drips from the sprayed leaves above. From our observations in hop gardens, and as most hop growers already know, this protective action of Bordeaux mixture is remarkably efficient. In mists or heavy dews, on the other hand, spores reaching the unsprayed cones would find sufficient moisture for germination without there being any great amount of dripping from the sprayed leaves above. Consequently there is as much or even more danger to the ripe hops in warm misty weather than in rainy periods unless every care has been taken to remove throughout the season the spikes which are the important origin of infection and to spray the foliage to prevent the formation of angular spots on the leaves which constitute the second important origin of infection for the cones.

Taking the past and present seasons as a whole it will be seen in Table I that the number of rainy days in the six months was for 1932, 109; 1931, 117; 1930, 112; 1929, 68; 1928, 86. In 1927 (when Downy Mildew caused much damage) 111 days were rainy. These figures demonstrate clearly that not the total number of wet days but rather the time of their occurrence in relation to the growth of the hop plant, is the factor to be considered in making comparisons between weather and damage by Downy Mildew. Thus in 1932, a year notable for the quality and health of the crop, there were about as many rainy days as in 1927 or 1931, in 1932, however, the months of June, July, and August were much drier, the total of rainy days being built up largely in April, May and September.

For particulars of the rainfall in the Midlands during the season of 1932, we are indebted to Mr. William Lionel Moore, Shelsley Beauchamp, Worcester, who has kindly placed at our disposal the rainfall figures recorded by Mr. J. F. S. Browne from which the details of the following Table II have been obtained.

TABLE II.

Rainfall. Church House, Shelsley Beauchamp, Worcester.
April to September, 1932.

Month.	No. of days.	No of days on which rain fell.*	No of days on which 0·01 in or more of rain fell.	Total Rainfall in inches.	Shelsley Beauchamp deviation from Normal of Midland Counties.	Midland Counties Normal Mean Rainfall.† Inches.
April ..	30	27	24	4·02	+2·29	1·73
May .	31	27	22	6·71	+4·62	2·09
June .	30	6	4	0·87	—1·33	2·20
July ..	31	20	14	2·24	—0·20	2·44
August ..	31	8	8	2·98	+0·42	2·56
Sept. ..	30	17	15	2·59	+0·66	1·93

* Including those days on which a fall of rain was actually observed but less than 0·01 inch.
† Derived from weekly normals for Midland Counties (1881-1915).

From these figures it is seen that a long period with little rain occurred, as in SE. England, during June, July and August although the latter month was rather more

rainy than at Wye, Kent, and exceeded the normal by 0·42 inch. In April and May, fifty-four of the sixty-one days were rainy and probably provided ideal conditions for the formation of spikes while in the following three months only thirty-four rainy days (twenty-six appreciably wet) out of ninety-two, exactly matches the conditions at Wye, Kent, in the matter of rainfall and explains why a check to the Downy Mildew should have resulted.

SUMMARY.

1. The season of 1932 was notable for the exceptionally severe attack on the bine in May, probably due to that month being very wet. A shortage of bine was caused in many gardens.

2. The dry weather in June, part of July and the whole of August, brought the spread of the disease to a standstill. There was a notable absence of the infectious " angular spot " stage from June onwards. The rain at the end of July and the mists that occurred during August were favourable for the spread of the fungus where it existed.

3. The three routine sprayings with home-made Bordeaux mixture were sufficient as a rule to secure a perfectly healthy crop. In some cases, however, it became necessary to precede these with an additional application.

4. It was again found that no harm resulted from spraying hops when in burr.

5. Additional evidence was obtained that complete prevention of the Downy Mildew on the crop can be obtained without applying Bordeaux mixture to the cones.

6. Cases have occurred in the winter of 1931-32 where loss was suffered in hop gardens owing to Downy Mildew attacking and killing the rootstocks (" hills ").

THE SUFFOLK SHEEP: A SURVEY OF THE BREED

By N. L. Tinley, N.D.A.

Lecturer in Agriculture, South-Eastern Agricultural College, Wye.

A study of this breed was begun in November 1932. Detailed information was obtained from sixty-six flockmasters on the general management and feeding of their flocks; this material has been incorporated in this article together with data supplied by the Secretary of the Suffolk Sheep Breeders' Society, and information on wool obtained through the courtesy of Messrs. The Eastern Woolgrowers, Ltd.

A more fitting time to study the Suffolk sheep could hardly have been chosen, in view of the way in which the breed is weathering the almost universal depression and maintaining such a high level of prices and keenness of demand from buyers both at home and abroad.

History and Origin.

Towards the close of the eighteenth century, the native Norfolk Horned breed of sheep was first crossed with the Southdown. Rams were taken from Sussex to Norfolk to mate with the local breed and this cross soon came to be well known. A lengthy description of the parent breeds is unnecessary here, since the Norfolk is now almost extinct and the Southdown so well known. A few remarks on the Norfolk ewe taken from Youatt's book on sheep (1837, p. 307) are worthy of inclusion. He describes the Norfolk as a peculiar variety of heath sheep, with a long and slender carcase and legs, the face being mottled or black in colour. The hindquarters were large, but the forequarter was deficient, the shoulder and the chine sharp and unsightly; the wool short and fine, but small in quantity. Taken altogether, there was more resemblance to the deer in the Norfolk sheep than has been observed in any other species. They were very prolific, however, and could thrive on very scanty fare, and rendered unproductive land capable of bearing crops of corn. Both the ram and the ewe of the Norfolk Horned breed had horns.

In 1859 the Southdown × Norfolk Horned cross became officially known as Suffolks and classes were allotted to them at the Suffolk Agricultural Association's meeting. The Royal Agricultural Society of England first granted classes for the Suffolk at the Royal Show in 1886. Some of the pure bred Suffolk flocks of the present day can trace their descent from 1790 (Wallace, 1923, p. 685), but the breed has only been recognized as pure since 1810.

Among early breeders, George Dobito of Lydgate, Suffolk, played a most important part about 1850, but there appears to have been no pioneer of the breed to compare with John Ellman in the Southdown breed or Bakewell in the Leicester. Through many years of careful breeding and selection, fostered by the Suffolk Sheep Society, the breed has reached the position and popularity which it enjoys to-day.

Champion Suffolk Flock, 1932 The property of the Rt Hon the Earl of Ellesmere

DISTRIBUTION AT HOME.

There are established flocks of Suffolks in over seventy counties of Great Britain and Ireland, ranging from Ross-shire in the north to Kent in the south and Cornwall in the west. There are in all 358 registered flocks in Great Britain and Ireland. Of recent years the spread of the breed north of the Border has been very rapid, the majority of the Scottish flocks being devoted primarily to the production of rams for crossing purposes.

DISTRIBUTION ABROAD.

The Suffolk finds a place in almost every sheep breeding country of the world. The International Directory of Livestock Breeders (1928-1929) shows 26 flocks in Australia, 8 in New Zealand, 40 in Canada, and 21 in South Africa. These represent only the registered pedigree breeders and there are many more commercial breeders in the above countries. The Suffolk has been exported to Austria, Argentina, Australia, Belgium, Chile, Canada, Denmark, France, Finland, Germany, Ireland, Italy, Russia, Spain, Switzerland, South Africa, and the U.S.A.

During the year 1930, the following exports took place : South Africa 11 rams and 65 ewes, Canada 24 rams and 53 ewes, U.S.A. 14 rams and 67 ewes, Chile 8 rams and 2 ewes, Australia 6 rams and 5 ewes, Belgium 2 rams and 2 ewes, Germany 1 ram, Ireland 1 ram and 12 ewes, making in all a total of 273 sheep. For the purposes of comparison with other breeds, the figures for the Southdown and the Kent or Romney Marsh have been obtained ; during 1930 the Southdown Sheep Society issued 225 export certificates to accompany sheep going out of this country, whereas the Kent or Romney Marsh Sheep Breeders' Association issued 499 certificates.

POINTS OF THE BREED.

Head. Hornless. Face black and long, with muzzle moderately fine, especially in ewes. Ears medium length, black and fine texture. Eyes bright and full.

Neck. Moderate length and well set.

Shoulder. Broad and oblique.

Chest. Deep and wide.

Back and loin. Long and level. Well covered with meat and muscle. Tail broad and well set up. The ribs long and well sprung, with a full flank.

Legs and feet. Straight and black, with a flat bone of good quality. Woolled to knees and hock, clean below. Fore legs set well apart. Hind legs well filled with mutton.

Belly. Well covered with wool.

Fleece. Moderately short ; close and fine fibre without tendency to mat or felt together. Well defined, i.e. not shading off into dark hair or wool.

Skin. Fine, soft and pink in colour.

THE SUFFOLK SHEEP SOCIETY.

This Society was formed in 1886 and published its first flock book in 1887. Excellent records are available of the performance of the breed at home and in all those countries to which it has been exported. Records of the lambing performance of the

breed for the past thirty years have been kept. In addition to the main branch of the Society, which has its headquarters in Ipswich, there is a Northern area branch, a Northern Ireland branch and a Southern Ireland branch.

The official sales of the Society are held at Ipswich, Newmarket, Belfast, Dublin, and annually at the Highland Show. In addition to these, numerous lamb sales are held during the months of July, August and September.

For the convenience of buyers overseas who cannot personally visit the sales, the Society has appointed a special Purchasing Committee of expert buyers, who undertake to purchase and ship the sheep required by the foreign buyer.

Under the auspices of the Society, an annual flock competition is held. This is divided into four classes, flocks of over 350 ewes, flocks of 200 to 350 ewes, flocks of 100 to 200 ewes and flocks of 50 to 100 ewes. There is also a Challenge Cup for the best flock in any of the four groups. The competition takes place in October, the ewes being shown untrimmed. The stock rams have also to be shown and 10 ewe lambs per 100 ewes in the flock as a sample of the progeny of the flock. A cup is also given for the best Suffolk ewe lambs. These cups become the property of the holder if they are won by him three times in five consecutive years.

GENERAL MANAGEMENT.

All the flocks examined in the survey are registered Suffolk flocks, the ewes being mated to a Suffolk ram. Flocks from 15 English counties are included, as well as flocks from 4 Scottish and 4 Irish counties.

The year's flock management begins with the sorting and culling of the ewes. After this, the ewes are divided into flocks of 40-70 according to the number to be run with each ram. Some attempt is made to flush the ewes before mating in 73 per cent of the flocks examined. Of this 73 per cent, 14 per cent are run on clover aftermath, 20 per cent on fresh grass, 3 per cent are fed with concentrated food and 36 per cent are run on sainfoin, rape mustard or kale, often with a run back on to the corn stubbles. From the lamb averages of the 65 flocks examined, there is no apparent difference in the lambing results obtained between the flocks which are flushed and the flocks which are not.

Of the 65 flocks, 36 are arable flocks and run on arable land almost throughout the year, 24 are grass flocks and the remaining 5 are described as run equally on arable and grass land. In a number of the arable flocks, the ewes are taken out of the fold on to permanent or temporary grass land during very wet weather or in some cases a run back on to a temporary ley is provided all the time the flock is on a fold. In this way, the ewes have somewhere dry to lie at night and a certain amount of treading and spoiling of the folded crop is avoided.

There is no noticeable difference in the time of mating in arable and grass flocks. Fifty-seven per cent of the flocks examined are mated during the first half of August, 17 per cent during the latter half, 10 per cent during the first half of September, 10 per cent during the latter half and the remaining 6 per cent early in October. The six flocks examined in Ireland are all mated during the first half of August and so are the six flocks in Scotland.

The losses amongst ewes incurred during the gestation period averaged 1 per cent and at lambing time 2½ per cent, these figures being in agreement with the official figures from the Society's records of 3·22 per cent during the 1930-31 season.

The Suffolk is very prolific ; the lamb average for a number of years of the arable flocks examined is 152 lambs born per 100 ewes mated and 140 reared to weaning. The grass flocks have the slightly higher average of 157 lambs born and 148 reared to weaning per 100 ewes mated. The average of all flocks together is 154 lambs born and 142 reared to weaning. The official records kept by the Society of registered flocks showed an average of 134 lambs reared to weaning per 100 ewes mated in 1889, and 138 reared in 1930.

The lambs at birth are very dark in colour, but this soon grows out. The ewes are exceptionally good milkers and are quite capable of rearing the twins or even triplets which they frequently produce. Only eight of the sixty-five flocks examined lamb in the open, the remainder being taken either into permanent lambing yards or into temporary yards made for the purpose. Ewes and lambs are usually kept in the pens for a few days after lambing until the lamb gets properly on its legs and until the shepherd is sure the ewe is feeding it all right. Once the lamb is properly started, it will be very little trouble.

Shearing takes place at the end of April in one flock, in May in sixteen, in June in forty-five, and in July in one. Eleven of the flocks are washed before shearing.

The lambs are weaned at four to five and a half months old.

FEEDING.

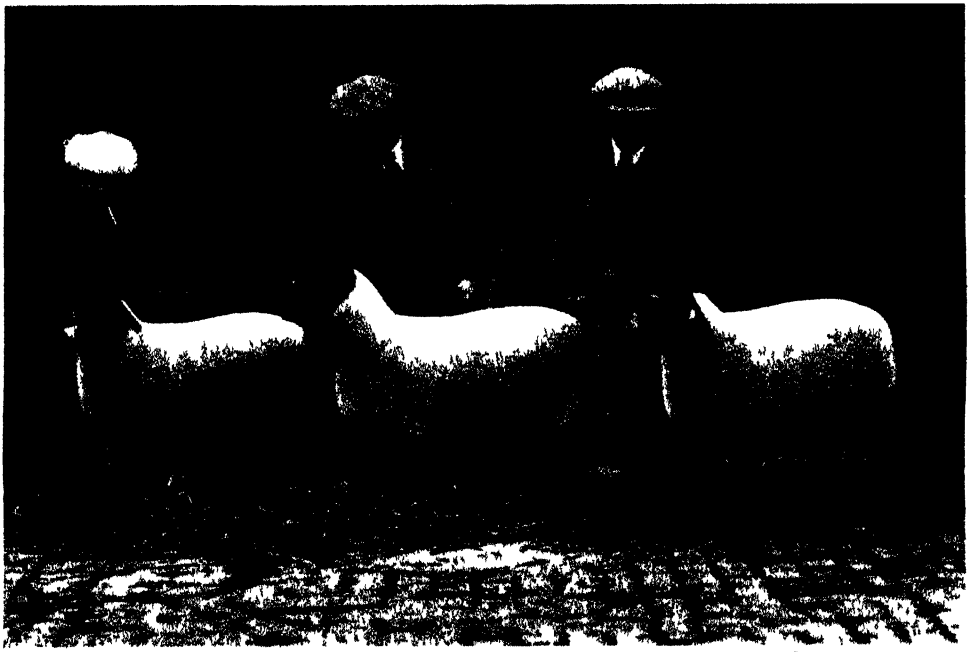
In arable flocks a succession of crops for folding purposes must be provided all the year round. The following table shows the principal crops used and the period of the year in which they are fed.

October.	Rape, mustard, kale, cabbage, sainfoin and clover leys.
November.	Rape, kale, turnips, sugar beet tops, sainfoin and clover leys.
December.	Rape, kale, turnips, sugar beet tops.
January.	Rape, kale, turnips, sugar beet tops, cabbages, swedes and kohl rabi.
February.	Rape, kale, swedes and kohl rabi, turnips or cabbage.
March.	Ditto ditto.
April.	Rape, kale, swedes and kohl rabi, cabbage.
May.	Temporary grass mixtures, clover leys, trifolium, rye, rye and oats, with usually a few mangels carted to the fold.
June.	Temporary grass mixtures, clover leys, trefoil and white clover, tares and oats or tares and beans.
July.	White clover, sainfoin, tares and clover leys.
August.	Tares and tare mixtures, kale, rape, cabbage, sainfoin and leys.
September.	Rape, mustard, kale, cabbage, sainfoin, clover leys, stubbles.

The lambing yard, if a temporary structure, is usually built near the crop on which the flock is folded. Creeps are made in the front of the fold so that the lambs may obtain the best of the crop in front of the ewes. In addition to this the lambs can then receive a separate ration of concentrates. When weaning takes place, the ewes are run on poor keep, generally on clover ley or grass land. The lambs are run on the best of

the crops available, in addition to which they receive concentrates ; working up to about 1-2 lb. in the case of ram lambs by about July and up to about half this quantity with other lambs.

During the winter months almost all ewe flocks receive hay, some of them regularly, some of them only during rough weather and some of them only during lambing time. Concentrated food is fed to the ewe flocks in every case except one, at some period during the winter. Eleven per cent of the flocks begin the concentrated food in November, 50 per cent in December, 36 per cent in January and 3 per cent in February. The time of commencing the feeding depends more on the time of year than on the stage of gestation. Oats is much the commonest constituent of the many and varied mixtures used, forty-



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Pen of three Suffolk lambs, the property of Hollesley Bay Labour Colony First prize and Championship at Norwich Fat Stock Show, 1932, and winners of the Breed Cup at Smithfield Show, 1932

three out of the fifty-five flockmasters who supplied information using it in their mixture. Linseed cake is used in twenty-nine of the rations, bran in twenty-three and cotton cake in fifteen. Dried grains, peas, beans, wheat, barley, maize, ground nut cake, sugar beet pulp, malt culms and various proprietary foods are all used, but not to the same extent. The quantity fed ranges from ½-2 lb. per head per day according to the condition of the ewes and the crop on which they are folded. The quantity used is increased at lambing time.

The majority of the flockmasters consulted devote their attention chiefly to ram breeding. Those rams which are not good enough to retain for sale as ram lambs are fattened either during the summer as fat lambs or during the autumn and winter as hoggets. Surplus ewe lambs are usually sold at one of the Society's official breeding

sheep sales. Seventy-seven per cent of the flockmasters who supplied information produce some ram lambs for sale, the remaining flocks producing fat lambs or store lambs.

Management of the Ewe Hoggets.

In arable flocks, these are run on arable crops during the winter and are usually well fed with concentrated foods in addition to the crop on which they are folded. In addition to this they usually receive a ration of hay or clover stover. In grass farms the hoggets are run on grass, usually with a ration of concentrates and in many cases roots carted on to the grass.

Smithfield Show.

An examination of the prize awards at the Smithfield Fat Stock Show for the last thirty shows (1900-1931 inclusive, there being no show in 1917 and 1918) reveals the fact that the Suffolk breed has won the championship for the best pen of sheep in the show on ten occasions against all other breeds. The championship for the best pen of short woolled sheep in the show has been awarded to a Suffolk pen on eleven occasions. The champion carcase in the sheep section has been a Suffolk on nine occasions. In the cross bred sheep carcase section, the champion has been a Suffolk on thirteen occasions.

At the Scottish National Fat Stock Show in 1932, a pen of three Suffolk lambs was exhibited weighing 580 lb. at 10½ months old, a very remarkable weight at such an age. These sheep were awarded the championship of the show and when killed yielded carcases of 111½ lb. each or 57·67 per cent of the live weight.

These successes are outstanding and speak significantly of the mutton qualities of the breed. In fat stock shows abroad, the breed has also been very successful.

Wool.

The Suffolk sheep produces wool which, in the opinion of a Bradford expert, has " exceptionally good, sound commercial characteristics. The quality is good 56's, the staple is nice length, sound and altogether ideal for hosiery purposes."

Another Bradford opinion is " the wool, if free from black fibres, ranks high among the down wools."

This sentence sums up the Suffolk wool. Its chief drawback is that in some fleeces a certain amount of black hairs are found in the fleece near the head and legs. This disadvantage is being overcome and the occurrence of this fault is getting less frequent. There are, however, a certain number of fleeces which have to be graded as greys (about 5 per cent).

The writer was given the opportunity of studying the grading of Suffolk wool at the Eastern Woolgrowers at Ipswich. The fleece weight of about 80,000 Suffolk sheep was found from the 1928, 1929, 1930, 1931, 1932 clips. The average weights of the fleeces for these five years was as follows :—

Washed ewe	..	3,999 fleeces averaged 4·48 lb.
Greasy ewe	..	56,818 fleeces averaged 5·73 lb.
Washed hogget	..	808 fleeces averaged 5·97 lb.
Greasy hogget	..	15,138 fleeces averaged 8·58 lb.

The practice of washing sheep before shearing is not commonly practised now, so that it was not possible to obtain a sufficient number of washed fleeces for reliance to be placed on the results obtained. The above figures include the wool of good and bad flocks and it is only fair to the breed to point out that in some flocks the ewes will average about 6½-7 lb.

The writer has studied the grading of 782,576 lb. of Suffolk wool. Of this quantity 56 per cent was graded as 56's and 39 per cent as 54's, the remaining 5 per cent being greys.

The wool is an excellent hosiery wool (for knitting purposes) and is also used in the manufacture of flannels.

The Journal of Textile Science (July 1924) gives the diameter of Suffolk wool fibres as 1/723 of an inch, the percentage of kemp as 0 and the percentage of black fibres as 8.

THE SUFFOLK FOR CROSSING.

The Suffolk is used for crossing with a number of other British breeds, both long-woolled and down. With the Cotswold, Lincoln and Leicester the Suffolk produces excellent mutton sheep. The breed is also crossed with the Southdown, sheep of this cross frequently taking a prominent place at fat stock shows. In the production of cross bred breeding ewes, the Suffolk has been used on Lincoln and Cheviot ewes and is probably deserving of more attention in this direction, as a Suffolk cross bred ewe would be prolific and of excellent mutton quality.

At the 1930 Smithfield show five out of nine entries in the class for cross bred lambs out of mountain ewes were Suffolk × Cheviot, and this cross filled the first and third places in the class. In the 1932 Smithfield show, Suffolk × Cheviot secured the first three places in the above class against entries from three other down breeds.

THE BREED IN SOUTH AFRICA.

The South African Suffolk Sheep Society has some thirty-five registered flocks and this is the only English breed to have a Society in South Africa.

The Suffolk has proved itself invaluable for crossing with native breeds of sheep and the chief aim of the flocks kept in South Africa is the production of rams for crossing purposes, though with the advent of frozen mutton from that country in 1933, the mutton of the Suffolk will probably come more to the fore.

The writer has been supplied with information on the feeding and management of two South African flocks. Mating takes place from the end of January to March, the ewes on these farms being flushed prior to mating on rape or green oats. The ewes are run on pasture during the winter, receiving 1-2 lb. per head per day of a mixture of oats and maize during lambing (June, July and August). In addition to this, they receive cow pea* hay or lucerne hay. The percentage of deaths during the gestation period and at lambing time average 3-4 per cent. The lamb average on one farm is given as 160 lambs born per 100 ewes mated and 140 reared to weaning and the other farm 130 lambs born and 110 reared to weaning. From these figures it would appear that the breed is just as prolific in South Africa as it is in this country and when mated to the South African Merino ewes, a cross bred breeding ewe is obtained which is much more prolific than the pure Merino, which seldom has more than one lamb. The sheep are

* A leguminous, bean-like plant grown in U.S.A. and South Africa for hay, silage and green manure.

shorn in September or October. One of these flocks is run on fresh oat pasture during the summer after lambing and the other is run on grass land. Supplementary feeding of oats and maize is given in each case. The lambs are weaned at 12-16 weeks old. Both of these flocks lamb in the open and the progeny are sold principally as rams for crossing purposes.

THE BREED IN THE U.S.A. AND CANADA.

The breed is very successful in the U.S.A. both for mutton production and for producing rams for cross breeding purposes. A Suffolk sheep society has been formed in the U.S.A. and many flocks, some of them up to 5,000 ewes, are in existence.

In Canada there are a number of flocks spread throughout the country, the reports from most centres being highly satisfactory.

PRICES.

The prices realized for Suffolk ram lambs for a period of five years at the principal sales are as follows :

Ipswich.	190 rams averaged	£23	8	6	in	1927.	
	126 ,,	£25	9	2	in	1928.	
	157 ,,	£24	13	4	in	1930.	Top price £273.
	154 ,,	£25	7	10	in	1931.	Top price £183 15s.
	150 ,,	£21	4	0	in	1932.	
Newmarket.	212 ,,	£14	16	10	in	1927.	
	223 ,,	£11	5	7	in	1928.	
	195 ,,	£13	17	5	in	1930.	
	177 ,,	£14	17	1	in	1931.	
	180 ,,	£9	14	10	in	1932.	
Kelso.	406 ,,	£11	11	2	in	1927.	
	348 ,,	£14	14	1	in	1928.	
	567 ,,	£15	6	5	in	1930.	
	643 ,,	£11	10	4	in	1931.	
	644 ,,	£10	0	0	in	1932.	

The comparatively small decrease in price from 1927 to the slump year of 1932 must be looked upon as highly creditable. In the 1932 sales eight ram lambs were sold for over 100 guineas each and some ewe hoggets were sold for the extraordinary sum of £30 each.

GENERAL.

The Suffolk is a breed which can be run equally well on arable or grass. It is very prolific, rearing to weaning about 140 lambs per 100 ewes mated ; these lambs are quickly on their feet and grow extraordinarily quickly, reaching big weights in a short time. The sheep are symmetrical and when ready for the butcher yield a high proportion of dressed weight to live weight, with mutton of good quality. As a sire for crossing with other British breeds or with native breeds abroad, the Suffolk is invaluable ; it is very prepotent and imprints its dark colouring of head and legs on its lambs.

Its spread during recent years has been very rapid and flocks are found in over seventy counties of the British Isles and in a number of countries abroad.

SUMMARY.

General.—The Suffolk is chiefly an arable breed but gives excellent results when run on grass land ; very prolific and an excellent crossing sire for fat lamb or mutton production when mated to any of the long-woolled mountain or down breeds.

Exports.—Has been very successfully exported to a number of countries and a variety of climates.

Sales held at Ipswich, Kelso, Newmarket, Belfast and Dublin.

Breeds Used in Development.—Was originally a cross between a Southdown ram and Norfolk Horned ewe. Has been bred true now for a very long time.

Date of First Flock Book.—1887.

Usual Lambing Time.—January, February and March.

Lamb Average.—140 lambs reared to weaning per 100 ewes mated.

Smithfield Live Weight Increase per Day.—Lambs ·68 lb. ; Shearlings ·43 lb.

Fleece Weights.—Washed ewe 4·48 lb. ; Greasy ewe 5·73 lb. ; Washed hogget 5·97 lb. ; Greasy hogget 8·58 lb.

Uses of Wool.—Flannels and hosiery.

Quality of Wool.—56 per cent 56's ; 39 per cent 54's.

Price per lb.—1929-31, 7½d.

Diameter of Fibres.—1/723 inch.

Per cent Kemp.—0.

Per cent Black Fibre.—8.

Method of Disposal.—Chiefly as rams for crossing purposes at home and abroad. Also an excellent fat lamb producer and mutton breed.

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THE SOUTHDOWN SHEEP

By N. L. Tinley, N.D.A.,
Lecturer in Agriculture, South-Eastern Agricultural College, Wye.

A survey of the Southdown breed was begun in November 1931. Information was collected chiefly by means of a questionnaire sent to breeders of these sheep; this met with a generous response, detailed information being obtained from about sixty flocks in Great Britain as well as flocks in New Zealand and the United States of America. In addition to this, Messrs. The Southern Woolgrowers, Ltd., put a quantity of figures at the writer's disposal.

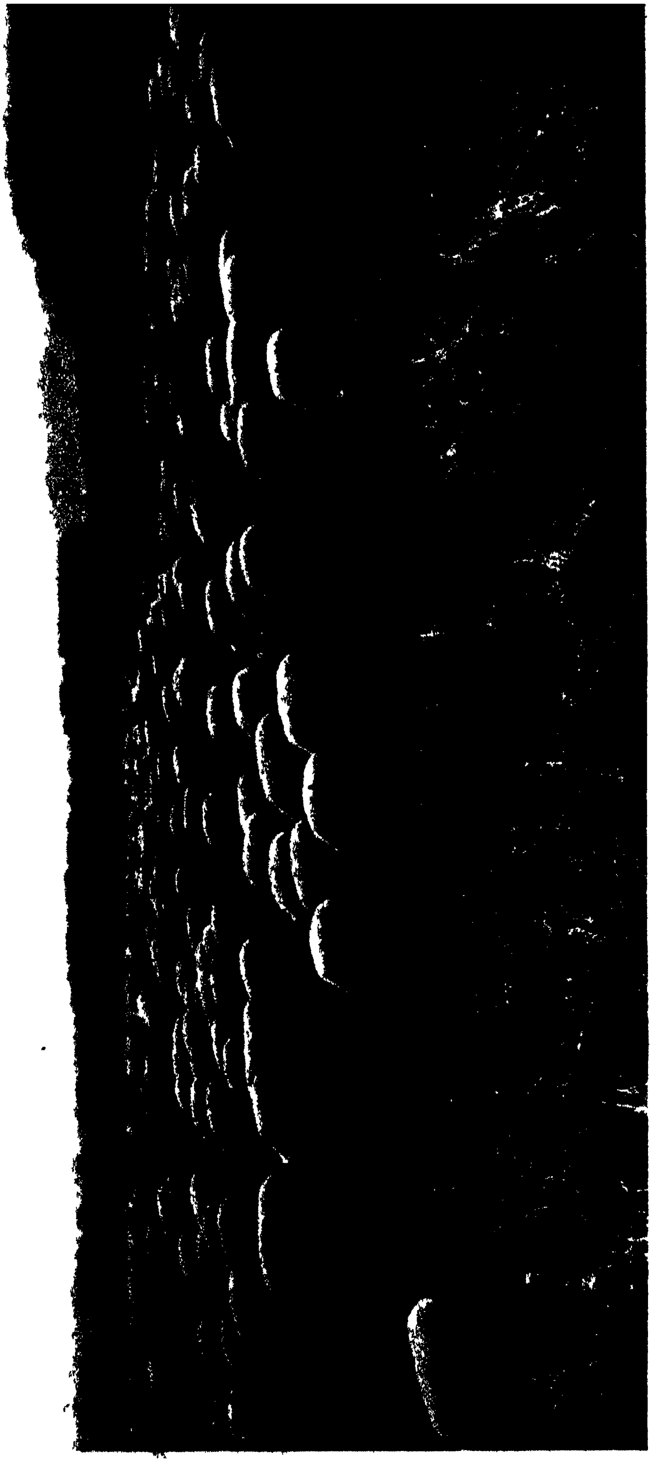
History.

The breed is indigenous to the South Downs, a range of chalky hills some sixty miles in extent stretching from West Sussex to Eastbourne. The area of sheep land was computed by Arthur Young, one of the earliest agricultural writers, as 150,000 acres, but it is commonly spoken of as being greater than this. The soil is thin and the pastures mainly of poor quality. It is on and near this range of rolling down land that the Southdown sheep, as it is known the world over, was evolved from the local breed of sheep which had grazed the downs from time immemorial. Its early history is obscure and it is not until the time of Mr. John Ellman, the famous breeder of these sheep, that adequate information is available. Arthur Young, writing in 1776, sums the breed up as follows: "Fine wool is certainly a considerable object, provided it is gained on a well-formed carcase; but if fine wool is procured at the expense of a thin chine, low fore end and rising backbone, the advantage is purchased too dearly. The faults most common in the Southdown breed are these three." John Ellman succeeded his father at Glynde Farm, near Lewes, in 1780, and soon after that date began to improve the breed by systematic breeding. Leicester and Merino blood were used in an attempt to improve the breed, but each proved a failure. The actual improvement was obtained by careful selection with a minimum of in-breeding. In 1787 Ellman sold two rams for ten guineas each, a price exceeding any previously obtained. In 1796 Ellman sold the first fifty guinea ram and there became a regular demand for Glynde rams, a great many at this time going to Norfolk. Ellman both let and sold rams; the best price he ever obtained for the letting of a ram was three hundred guineas for two seasons. Two rams were sold to the Emperor of Russia for three hundred guineas about the same time. The work of breeding and improving the breed was carried on by Jonas Webb, who farmed in Cambridgeshire and began breeding Southdowns about 1821. The skill of these early breeders was such that the breed has gained for itself world wide renown as a mutton sheep of unrivalled qualities and one which carries a fleece finer in quality than any other British breed.

Points of the Breed.

The points of the Southdown sheep as given in the Flock Book are as follows:

Head:	Wide, level between the ears, with no sign of slug or dark poll.
Face:	Full, not too long from the eyes to nose and of one even mouse colour, not approaching black or speckled. Under jaw light.



A Southdown Ewe Flock.

Eyes:	Large, bright and prominent.
Ears:	Of medium size and covered with short wool.
Neck:	Wide at the base, strong and well set on to the shoulders. Throat clean.
Shoulders:	Well set, the top level with the back.
Chest:	Wide and deep.
Back:	Level with a wide flat loin.
Ribs:	Well sprung and well ribbed up, thi k through the heart, with fore and hind flanks fully developed.
Rump:	Wide and long and well turned.
Tail:	Large and set on almost level with the chine.
Legs of mutton:	Full, well let down, with a wide twist.
Wool:	Of fine texture, great density and of sufficient length of staple, covering the whole body down to the hocks and knees and right up to the cheeks, with a full fore top, but not round the eyes or across the bridge of the nose.
Skin:	Of a delicate, bright pink.
Carriage:	Corky, legs short, straight and of one even mouse colour, and set on outside the body.

Disqualifications are horns or evidence of their presence, dark poll, blue skin or speckled face, ears or legs.

DISTRIBUTION IN GREAT BRITAIN.

The breed has spread widely over certain parts of England, mainly the southern half, and registered flocks are to be found in the following counties: Berkshire, Bedfordshire, Cambridge, Devon, Essex, Gloucester, Hampshire, Hertfordshire, Kent, Lancashire, Lincolnshire, Nottinghamshire, Norfolk, Oxfordshire, Sussex, Surrey, Suffolk, Shropshire, Wiltshire, Warwickshire, Worcestershire and the Isle of Wight. There are eight registered flocks in Wales and one in the Irish Free State.

DISTRIBUTION ABROAD.

The International Directory of Livestock Breeders (1928-29) records 300 Southdown flocks in New Zealand, 250 in U.S.A., 21 in Australia and 9 in Tasmania. In addition to this rams are used in many other countries for crossing purposes. The breed is spoken of as being successful in the U.S.A. as early as 1803. Importation from then onwards from the flocks of T. Ellman (son of John Ellman), Jonas Webb and other well-known breeders have taken place regularly. The American Southdown Breeders' Association was founded in 1882 and now has 350 members.

THE SOUTHDOWN SHEEP SOCIETY.

This Society was formed in 1892. In all, 1,072 flocks had been registered up till the publication of the 1932 flock book, in which are 253 registered flocks, or a total of 51,692 ewes put to ram. In addition to this there are about 32,000 registered ewe tegs. The headquarters of the Society are in Chichester. The Society offers five

special prizes at the Royal Agricultural Society of England's Show, three at the Royal Counties Show, two at the Three Counties Show, three at the Sussex Show, two at the Suffolk Show and many other prizes at other county and local shows. The Society offers prizes at some lamb sales for the best pen of lambs sired by a Southdown ram.

EXPORT.

Sheep for export must be accompanied by a certificate of pedigree when leaving the country. The total number of Southdown sheep exported during 1930 was 225, an increase of 74 over 1929. Of these sheep, 18 rams and 22 ewes went to Australia, 1 ram and 2 ewes to Belgium, 11 rams and 39 ewes to Canada, 40 rams to France, 1 ram to Ireland, 5 rams and 3 ewes to Siam, 24 rams to Spain, 4 rams and 9 ewes to Tasmania, 19 rams and 27 ewes to U.S.A. Exportations have been regular and the breed finds a place in almost every sheep raising country of the world.

GENERAL MANAGEMENT.

The fifty-six flocks included in this investigation can be divided into two groups, the hill flocks and the lowland or underhill flocks; the management of the two groups differs slightly as will be seen from the following data. The breed is equally at home on arable land or grassland, being particularly well adapted for folding on arable land. Of the lowland flocks studied, half are arable flocks and half are grass flocks, while one-third of the hill flocks are arable flocks, one-third are grass flocks, and the remaining third are run on grassland during the day and folded on arable crops at night. This practice of driving the flock from grassland to the fold is commonest on farms which have some downland grazing, on which the flock grazes during the day, being driven down to an arable fold for the night.

A succession of crops for folding is grown for the arable flocks all the year round, great skill being needed if the crops are to be ready at the right time and provide a regular supply of fodder for the flock. The following cropping calendar gives the principal crops used and shows the approximate period of the year in which the crop is u ilized.

September:	Sainfoin. Clover Leys. Mustard. Rape. During this month the flocks are sometimes run over the corn stubble.
October:	Turnips. Mustard. Rape.
November:	Turnips. Sugar Beet tops. Rape. Kale.
December:	Turnips. Sugar Beet tops. Rape. Kale.
January:	Turnips. Swedes. Rape. Kale.
February:	Swedes. Rape. Kale.
March:	Swedes. Kale.
April:	Rape.
May:	Rape. Kale. Winter Barley. Seeds Leys.
June:	Winter Barley. Winter Vetches. Seeds Leys.
July:	Winter Vetches. Spring Vetches. Seeds Leys. Oats and Vetches. Rape and Vetches.
August:	Second crop Sainfoin. Spring Vetches. Seeds Leys.

In addition to the grass or the arable crop on which the flock is being maintained, a ration of hay (1-2 lb. per head per day) is almost invariably fed either throughout the winter or during periods of rough weather. In a few flocks straw is used instead of hay. The practice of feeding concentrates during the winter is almost invariably followed by Southdown breeders; in only 4 per cent of the flocks examined is no concentrated food fed at all. In a few (3 per cent) the ewes are fed concentrates during the last three months of the gestation period and in 11 per cent of the flocks during the last two months. Nine per cent of the flockmasters begin feeding six weeks before lambing and 48 per cent during the last month before lambing. The remaining flockmasters defer the start of feeding until lambing begins. The quantity fed per head per

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Southdown Shearling Ram First Prize at Royal Show, 1930; bred by J Pierpont Morgan, Esq

day varies according to the condition of the flock, the weather conditions and the available quantity of grass or arable crops, but the average is ½-¾ lb., this being increased in most cases at lambing time. The foods most commonly used are cotton cake, oats, dried grains, bran, linseed cake, maize, sugar beet pulp, peas and beans. Where the flock is folded after lambing, it is customary to allow the lambs to go in front of their dams, through lamb creeps, so as to obtain the best of the crop and in addition, as soon as they will eat, a trough is placed beyond the creep, so that the lambs can be given concentrates apart from their dams. Lambing begins in January and goes on into March, the lowland flocks lambing a little earlier than the hill flocks, owing to the more sheltered ground and the more forward condition of the crops and the grass. Only two of the flocks examined lamb in the open, the remainder being provided either with a permanent lambing yard or with a temporary yard made from thatched or wattled hurdles. The ewes and lambs are usually kept in the yards for four or five days after lambing.

The Southdown Sheep Society keeps lambing records of a number of pedigree flocks and these records show an average of 122 lambs per 100 ewes mated. In the 1932 records for flocks of over 200 ewes the largest and the smallest number of lambs per 100 ewes mated were 142 and 110, while in the section for flocks of under 200 and more than 50 ewes, the largest and smallest figures were 156 and 101. In the 56 flocks in this survey, which includes both commercial and pedigree flocks, the average number of lambs born per 100 ewes mated is 115 and the average number reared to weaning 108. Flocks which are flushed on mustard or rape show a tendency to produce more lambs than those which are not flushed. The practice of flushing the ewes before mating is only carried out in about half of the flocks under discussion. By providing a change of keep, richer or additional food just before mating, the ewes are got into steadily improving condition before going to ram and tend to produce more twins.

The remainder of the data supplied is best shown as percentages in the form of a table, so that the differences in the management of the hill and lowland flocks can be more readily seen.

SUMMARIZED DATA OF THE MANAGEMENT OF FIFTY-SIX SOUTHDOWN FLOCKS.

	Hill Flocks.	Lowland Flocks.
A. *Method of Flushing Ewes for Mating.*	%	%
No flushing attempted	44	43
Fresh grass	9	10
Seeds ley or second cut clovers	13	7
Mustard or rape	30	33
Concentrates	4	4
Stubbles	0	3
B. *Date of Mating.*		
August	9	37
September	41	41
October	50	22
C. *Shearing Date.*		
Early May	0	3
May	13	28
Late May or early June	35	30
June	52	36
July	0	3
D. *Losses among Ewes during the Year.*		
During gestation	1	⅔
At lambing	2½	2
E. *Lamb Average.*		
Lambs born (per 100 ewes mated)	112	119
Lambs reared to weaning (per 100 ewes mated)	103	113
F. *Date of Weaning.*		
May	0	18
June	59	61
July	41	15
August	0	6

G. *Method of Disposal of Lambs.*	*Hill Flocks.*	*Lowland Flocks.*
	%	%
Store lambs at autumn sales	47	11
Fat lambs and ram lambs	0	15
Fat tegs and ram lambs	0	11
Store lambs and ram lambs	24	19
Fat lambs, fat tegs and ram lambs ..	0	11
Store lambs and ewe tegs	6	7
Store lambs and fat tegs	6	4
Fat tegs almost entirely	17	11
Fat lambs, ewe tegs and ram lambs ..	0	11

PRICES REALIZED.

The demand for Southdown sheep is keen both at home and abroad. The number of rams sold at the Chichester Ram Sale in an average year is 800, of which 450 are ram lambs and the remainder older sheep. At Lewes, some 400 rams are sold, of which 250 are ram lambs. The prices realized for the past seven years are perhaps best shown in the form of a table.

PRICES OF RAMS AND RAM LAMBS AT CHICHESTER RAM SALE.

Year.	*Ram average price.* £	s.	d.	*Ram lamb average price.* £	s.	d.
1926	15	11	2	7	12	7
1927	15	19	9	8	8	8
1928	14	9	0	6	9	8
1929	9	8	2	6	18	3
1930	10	8	2	5	18	7
1931	10	0	0	5	18	7
1932	7	5	2	4	6	8

The top prices in these years range from £68 5s. in 1926 to £136 10s. in 1929 for rams and from £27 6s. in 1932 to £136 10s. in 1928 for ram lambs.

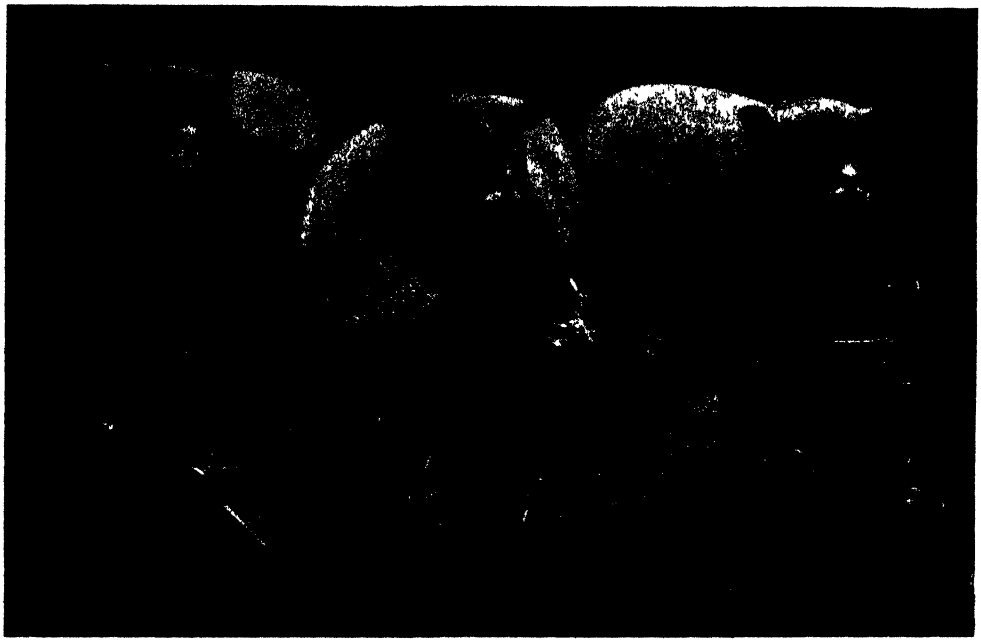
Wether lambs sold as stores at Findon Fair have realized up to the following prices: in 1926 £3 13s., in 1927 £3 17s. 6d., in 1928 £4, in 1929 £3 11s., in 1930 £4, in 1931 £3 3s. 6d., in 1932 £2 8s.

GENERAL.

The Southdown has justly earned world-wide fame as a sire for crossing with other breeds for mutton production. It has been used for this purpose with almost all the Southern British breeds and in the evolution of nearly all our Down breeds the Southdown has played a big part. The Suffolk was first produced by crossing a Southdown ram with Norfolk Horn ewes, and most of the other Down breeds have at some stage in their history been indebted to the Southdown for improving their symmetry, wool and mutton production. In New Zealand, the Southdown is used for crossing with the Kent or Romney Marsh sheep to produce the famous Canterbury lamb for export. That the breed is capable of adapting itself to a variety of climatic conditions is demonstrated by the number of countries abroad to which it has been and still is exported.

THE BREED IN NEW ZEALAND.

Through the kindness of Mr. W. McKenzie, the Secretary of the New Zealand Southdown Sheep Society, the writer has been able to obtain detailed information of the management of nine flocks in New Zealand. The flocks from which the information is taken are situated in the following provinces: Canterbury, 3; Otago, 1; Wellington, 4; Hawkes Bay, 1. The management in all the flocks is more uniform than in the English flocks. In only one flock is any attempt made to flush the ewes for mating, some form of green crop or turnip tops being used in this case. In the other eight flocks, the flock-masters rely on the young grass, of which there is a fair supply at mating time. Mating takes place at the beginning of April in one flock and during March in the other eight.



Pen of Three Shearling Ewes.

Five flocks are run on grass only, two are turned on to turnips for a few hours each day, one is run on turnips for a month while in lamb and the remaining one has swedes or turnips carted on to the grass. In none of the flocks is any form of concentrated food used and only in three flocks is hay regularly used as a supplementary feed. The percentage of deaths while in lamb is 1 per cent and deaths at lambing time 4½ per cent. All the flocks are lambed down on grass, in one flock mangels being carted on to the grass as a supplementary food.

The lamb average per 100 ewes mated is 104 lambs born and 97 lambs reared to weaning. Six of the flocks are shorn during November, one during December and two during either month. Weaning takes place during December in two flocks and during January in the remaining seven. Lambing takes place in the open in seven flocks, in sheds in one and in a small paddock in one, with small pens provided for the ewes and lambs for a few days after lambing. The lambs not required for sale as rams or for the

maintenance of the flock are sold as fat lambs to the freezing works for export. The ewe lambs and ram lambs are wintered, the latter being sold as shearlings, the majority of which are used for crossing with Romney Marsh ewes to produce lamb and mutton for the export trade. These ram lambs are run through the winter mainly on grass with swedes, turnips and rape carted to them. In addition to this, they are given oat straw, oat sheaf chaff or hay as supplementary feed and are sold as two tooths at the age of about eighteen months.

The Breed in U.S.A.

Mr. W. L. Henning, Secretary of the American Southdown Breeders' Association, very kindly supplied information on the general management of the breed in the U.S.A. The information given is the average management of a flock in the states of Pennsylvania, Ohio, Indiana, Illinois and New York. The ewes are turned on to fresh grass for flushing and are mated between mid-September and mid-October. At the beginning of December the ewes are brought indoors and are then fed on alfalfa hay or mixed hay, corn (maize) silage and a grain mixture of maize, oats, wheat bran and linseed cake. The flocks are indoors until 1 May. The quantities of the above rations consumed indoors are usually about ½ to 1 lb. of grain and 2 to 4 lb. of hay per head per day. The percentage of deaths while in lamb is very small and at lambing time about 1 to 2 per cent. The lamb average is given as between 100 and 140 lambs born per 100 ewes mated.

The ewes are shorn at the end of April and the beginning of May. As in New Zealand, the sheep are not washed before shearing. From the beginning of May, when the flocks are turned out, they are pastured on bluegrass (smooth stalked meadow grass) until weaning, which takes place between mid-June and mid-July. If the lambs are kept after weaning, they are pastured on forage crops such as rape, oats or peas. The majority of the lambs are sold as fat lambs during the summer (1 July to 1 September). Southdown sheep have not been exported from the U.S.A.

Owing to the tremendous variations in climatic and farming conditions in the U.S.A., it is not possible to give any more than a very general description of the management of the flocks. The real centre of the Southdown breed in the U.S.A. is Kentucky and Tennessee ; in these states the climate is warmer and lambs are usually dropped in January, being marketed in May and June as early spring lamb.

Wool.

Through the courtesy of Messrs. The Southern Woolgrowers Ltd. the writer was given the opportunity of studying some of the wool records. The average weight of Southdown ewe and teg fleeces was determined for five years (1925 to 1929 inclusive). The number of fleeces included in these averages was 76,992, the average fleece weights being as follows :—

Greasy Ewe	..	4·89 lb.
Washed Ewe	..	3·84 lb.
Greasy Teg	..	6·16 lb.
Washed Teg	..	3·99 lb.*

* Too much reliance must not be placed on this figure as it was only possible to obtain the weights of 1,249 washed teg fleeces.

No other British breed of sheep produces wool of finer quality than the Southdown. Its wool has been renowned since the earliest records. Youatt writing in 1837 gave the average weight of the fleece of a hill Southdown sheep as 3 lb. and the weight from a lowland Southdown sheep as 3½ to 4 lb. From the figures worked out by the writer and given above, it would appear that the fleece average has been considerably increased.

The average price realized for Southdown wool was 16½d. per lb. in 1926; 19½d. in 1927; 19½d. in 1928 and 11d. in 1929. It is rather interesting to note that it was not until 1900 that Southdown wool began to realize more money per lb. than other breeds. In 1920 Southdown wool reached 4s. per lb. It is very dense and compact and is entirely free from black fibre and kemp, the average diameter of the fibre being 1/879th of an inch. The quality is given by the University of Leeds* as 81 per cent 56's and 19 per cent 50's. American Southdown wool is ½ to ⅜ blood, or on the Bradford system of counts 56's to 60's with a few fleeces as low as 48's. It is the best wool produced in U.S.A. by a mutton breed. In New Zealand the wool produced in the North Island is said to be stronger and longer than that produced in the South Island. The general quality is about 56's to 60's. Southdown wool has been tested by the writer for medullated fibres and has been found quite free.

MUTTON.

The quality of the Southdown mutton is known the world over. The proportion of lean meat to fat is high and the fat is of good quality and not tallowy. The joints are small and compact and of suitable size to suit modern tastes, having a minimum amount of bone and consequently little waste. The proportion of carcase to live weight is high and in consequence the Southdown is an economical butcher's sheep In France, the famous prés salés mutton is derived from Southdown sheep and Southdown crosses bred chiefly on the sea coast of Normandy and Brittany.

SALES.

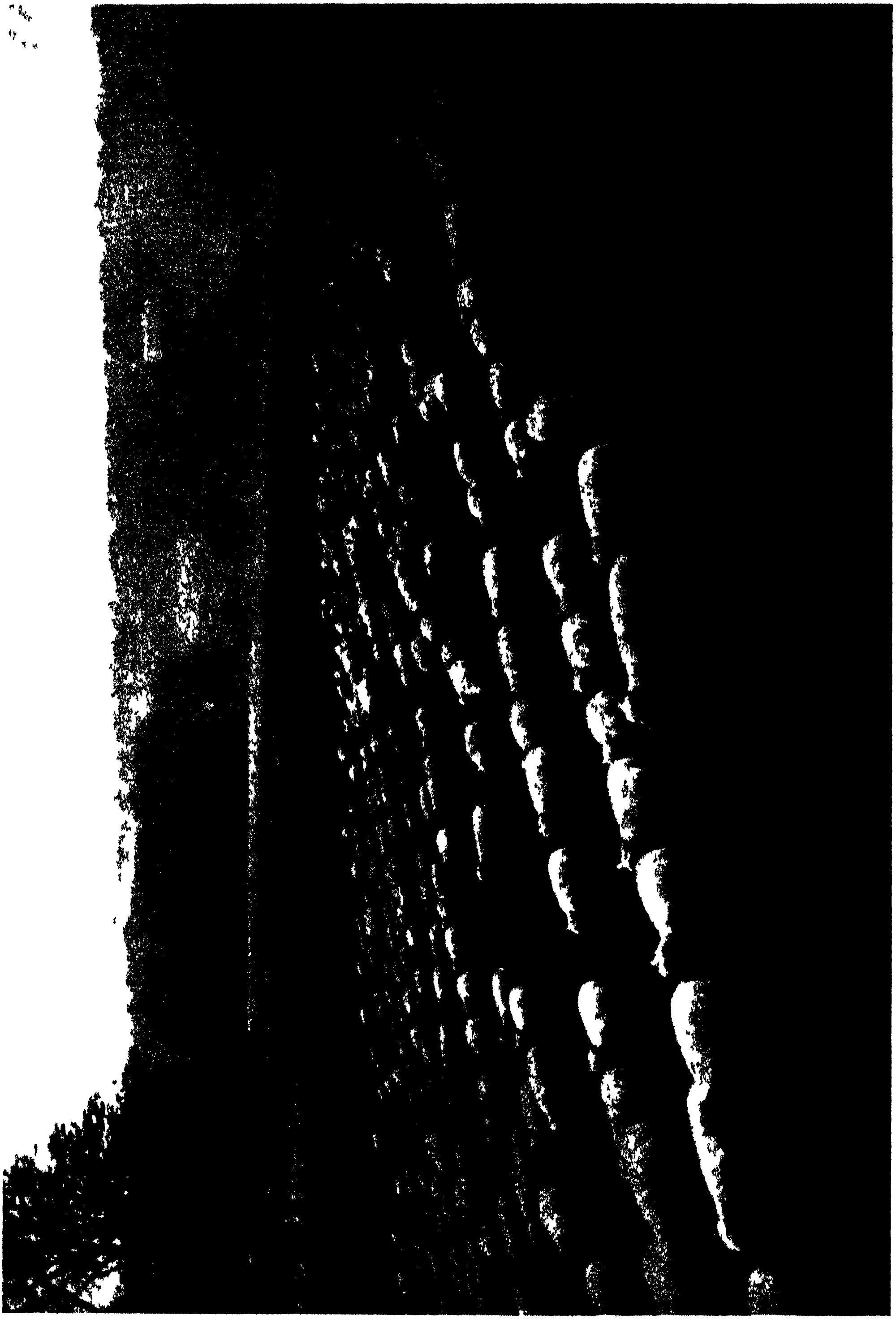
Southdown sheep sales are held under the auspices of the Southdown Sheep Breeders' Association at a number of centres, amongst which Lewes and Chichester are probably the best known. Other well known sales and fairs are held at Findon in Sussex and Bourton-on-the-Water, Gloucestershire.

SHOWS.

The breed is always represented at the Royal Agricultural Society of England's Show in considerable numbers, no matter in what part of the country the show may be held.

At Smithfield Fat Stock Show, the breed's record is unrivalled. Ten years' records show that in the classes for lambs, 423 9½ months old animals averaged 147 lb. live weight or a daily live weight increase from birth of ·50 lb. In the classes for sheep over one year old, 297 sheep averaged 201 lb. live weight or an average increase in live weight per day of ·31 lb. Up to 1920, out of the previous forty-nine shows, the breed had won the supreme championship over all breeds on twenty-three occasions, the total of the nearest rival being eight. In addition to this, almost every year the champion carcase has been either a pure bred Southdown or a Southdown cross. In 1930 the first five places in the wether lamb class for short wooled breeds were gained by Southdowns, while in the classes for sheep over a year old they filled the first two places.

* *Journal of Textile Science*, July 1927.



A Southdown Ewe Flock on Park Land

At the Chicago International Live Stock Exposition in 1930 the champion wether was a pure bred Southdown lamb, the reserve champion a Southdown cross, while the breed also won the Champion Carload. The champion carcase was a Southdown cross and the reserve champion a pure bred Southdown.

These results, which numerically represent but a small proportion of the awards made to the breed, are significant testimony of the breed's unrivalled qualities as a mutton producer.

Summary.

General. The Southdown is an excellent mutton sheep producing finer wool than any other British breed. It is good for grass or arable land. It is invaluable as a sire for crossing purposes. The breed is widespread over England and there are a number of flocks in Wales.

Exports. The Southdown has been exported to almost every sheep-breeding country in the world.

Sales are held at: Chichester, Lewes, Findon and Bourton-on-the-Water.

Breeds used in Development: None. Bred pure for generations.

Date of foundation of Flock Book: 1892.

Usual Lambing Time: January, February and March.

Lamb Average: 115 per cent born; 108 per cent reared to weaning.

Smithfield Live Weight Increase per day, Shearlings: ·31 lb.

Smithfield Live Weight Increase per day, Lambs: ·50 lb.

Fleece Weight:	Greasy Ewe ..	4·89 lb.
	Washed Ewe ..	3·84 lb.
	Greasy Teg ..	6·16 lb.
	Washed Teg ..	3·99 lb.

Uses of Wool: Hosiery, flannels and felts.

Quality of Wool: 81 per cent 56's, 19 per cent 50's.

Price per lb., 1926-1929: 16½d.

Diameter of Fibre: 1/879th of an inch.

Percentage Black Fibres: 0.

Percentage of Kemp: 0.

Method of Disposal: As store lambs at the autumn lamb sales, or as ram lambs or shearling rams at the ram sales, or as fat tegs when nearly a year old. The breed, owing to its rapid growth rate, will produce excellent fat lamb at an early age.

Conclusion.

The writer wishes to take this opportunity of thanking the many farmers who supplied him with information on so many points of feeding and management. Without their help, much of this paper could not have been written. The writer would also like to express his thanks to Messrs. W. O. Stride and W. P. Ballantine, Secretary and Assistant Secretary of the Southdown Sheep Society, for their help and to Mr. R. Ball, Secretary of the Southern Woolgrowers Ltd., for putting at his disposal so much information on Southdown wool.

A STUDY OF NORTH-WEST CHESHIRE (*WIRRAL*) SOILS

By A. JAMES LOW, M.Sc.(Liv.), A.I.C.

THE area in which the soils have been studied is known as the Wirral Peninsula. It is bounded on the West by the Dee Estuary, on the East by the Mersey and on the North by the Irish Sea. As will be seen from Tables 3 and 4, the climate is equable, being warm in winter and cool in summer. The average rainfall is not high.

Geologically, the area is comparatively simple. On the high land in the North-east and down the West side are outcrops of Triassic sandstones, the Bunter being exposed to the West and North-west and the Keuper more on the East side, although it is also found on the West. The lower land is covered with recent deposits, chiefly Boulder Clay with a patch of Shirdley Hill Sand. The Boulder Clay forms quite a large proportion of the area studied.

To-day the higher land in the North-west and North-east is largely residential, but the central region still remains agricultural. Tables 1 and 2 show that this agriculture is somewhat varied, and examination of the country makes it clear that there is a close relationship between the geological material and the distribution of arable and grassland. In general, it may be said that the land on the Triassic sandstones is either under the plough, or, where the soil is very shallow, it is covered with heathland, while there is little of the Boulder Clay which is not under permanent grass.

The soils on the Triassic sandstones are light in texture, being usually well-drained sandy loams, easily cultivated. Until recently, at least, owing to the excellent markets of Birkenhead and Liverpool, they have been kept under cultivation, and this is so to-day for the greater part of the land, except for that which is about to be built upon. The chief crops are oats, potatoes and wheat, but there is much more oats than wheat.

It is chiefly on the rising ground that the soils formed from the Triassic sandstones are found, those on the lower being chiefly from Boulder Clay, and they are texturally similar in the upper horizons, but usually there is a considerable increase in the lower horizon to a clay mixed with sand. The drainage is not so good, due to the clay horizons. The land is fairly well stocked under normal conditions with cows, and here again there are excellent markets for the products.

In an area such as this, it is not easy to find a comparatively undisturbed soil, that is, one which has been allowed to develop its characteristics without the changes brought about by de-forestation and subsequent cultivation. However, in the woods we find soils which are relatively undisturbed, and possibly have never been cultivated, and here the soil-forming processes have been able to produce a soil which approximates to that which would be found in virgin forest land. Before proceeding further the limitations of the soil must be considered. Soil studies used to be limited to the "surface" soil, i.e. about 10 inches in depth, this being the part considered to be altered by cultivation, the composition of which was the chief factor in determining its suitability or otherwise for the agriculture to be practised. In the study and comparison of soils, little or no attempt was made to consider the effect of the underlying material down to the unchanged "rock" which might be a clay, granite, limestone, or some other geological material. But in modern field studies, because it is realized that the material

down to and possibly extending into the unchanged rock has a fundamental effect on the soil produced, the soil profile is examined. This is a section extending from the surface of the ground down to the unchanged deep-seated material and may vary from a few inches to many feet. In this profile many changes have been and are taking place, and these confer on the profile its characteristics. In the upper horizons of the profile, biological, chemical and physical changes are taking place, but lower down only the two latter. It is clear that different conditions of temperature, rainfall, parent material and vegetative covering will give different profiles.

In studying a profile in the field, as many characteristics as possible are noted, such as texture, colour, the reaction, the soil minerals, the height of the water table, the drainage conditions; and the source of the material and the topography are also observed. Thus two soils, widely separated in space but having identical or very similar profiles, will probably behave similarly with the same treatment, and can thus be classified together. The climate may be slightly different, but if there is a marked difference this will so affect the soil-forming processes that the field characteristics will differ markedly.

Before the soils of England, and the world, can be classified, those typical of different regions must be studied and compared as exhaustively as possible. The profiles which are to be described are considered to be fairly typical of those in the region studied. They are divisible broadly into two groups, those which approximate to the undisturbed profile, and it is these which are of greatest importance academically, and those which have resulted after ages of cultivation, and these are of chief interest to the agriculturist. Profiles having the same characteristics are said to be in the same series and are given the same name, e.g. Haddon Series.

The following are descriptions of profiles developed on the various rocks, Triassic and Recent, found in the Wirral Peninsula.

39 W.—THORNTON SERIES.

Geology: Bunter Pebble Beds. Origin: Sedentary.
Colour: Dark Brown. Topography: Flat. Drainage: Good.
Profile: 0-24" Dark brown sandy loam passing into reddish-brown sand.
24" Red sandstone.

51 W.—HOUGH SERIES.

Geology: Bunter Pebble Beds. Origin: Sedentary.
Colour: Brown. Topography: Slight slope to S.E. Drainage: Good.
Profile: 0-19" Brown sandy loam.
19-26" Reddish fine sandy loam—increase in clay fraction.
26-30" Red sand.
30" Red sandstone.

37 W.—NESS SERIES.

Geology: Bunter Pebble Beds. Origin: Sedentary.
Colour: Brown. Topography: Flat. Drainage: Good.
Profile: 0-8" Brown sandy loam.
8-22" Lighter brown sandy loam.
22-24" Slightly iron-stained sandy loam.
24-36" Yellow sand with iron stains.
36-37" Reddish-brown sand.
37" Red sandstone.

18 W.—NESTON SERIES.

Geology : Bunter Pebble Beds. Origin : Sedentary and some colluvial.

Colour : Grey. Topography : Flat. Drainage : Partly impeded.

Profile :
- 0-3″ Grey sandy loam.
- 3-8″ Brown sandy loam.
- 8-16″ Brown sandy loam—some red iron-stained sand particles—also red sand.
- 16-30″ Red clay—large amount of iron oxides.
- 30″ Red sandstone.

33 W.—BRIMSTAGE SERIES.

Geology : Bunter Pebble Beds. Origin . Sedentary.

Colour : Light Brown. Topography : Flat. Drainage : Good.

Profile :
- 0-18″ Light brown sandy loam with white sand grains and with some round pebbles.
- 18-24″ Iron-stained sand.
- 24-26″ Almost white sand.
- 26-32″ Brownish sand.
- 32-38″ Very pale yellow sand.
- 38″ Pale yellow sandstone.

24 W.—HADDON SERIES.

Geology : Bunter Pebble Beds. Origin : Sedentary.

Colour : Black. Topography : Almost flat. Drainage : Good.

Profile :
- 0-3″ Pine needles, dead bracken, etc.
- 3-7″ Black sand, large quantities of humus.
- 7-11″ Bleached sand with some humus.
- 11-14″ Purplish-black sand—also iron-stained.
- 14-16″ Light brown iron-stained sand.
- 16-22″ Yellowish-brown sand.
- 22″- Reddish-yellow sandstone.

85 W.—NESS SERIES.

Geology : Upper mottled sandstone. Origin : Sedentary.

Colour : Brown. Topography : Top of slope. Drainage : Good.

Profile :
- 0-8″ Brown sandy loam.
- 8-16″ Brown fine sandy loam with increase in amount of clay.
- 16-21″ Yellowish-brown sand.
- 21-23″ Reddish slightly iron-stained sand.
- 23″- Sandstone.

91 W.—NESTON SERIES.

Geology : Upper mottled sandstone. Origin : Sedentary and possibly some Boulder Clay.

Colour : Dark Brown. Topography : Slight slope to N.E. Drainage : Good.

Profile : 0-10" Dark brown fine sandy loam.
10-16" Slightly lighter brown very fine sandy loam.
16-21" Slightly bleached brown sandy loam.
21-26" Reddish-brown sandy clay.
26-30" Buff coloured sandy clay.
30-35" Reddish-brown sandy clay.
35-36" Red sand.
36"- Sandstone.

95 W.—Haddon Series.

Geology : Upper mottled sandstone. Origin : Sedentary.

Colour : Black. Topography : Slight slope to North. Drainage : Good.

Profile : 0-3" Black peaty material.
3-6" Black fine sandy loam with a great many white sand grains.
6-8½" Bleached sand—slight purplish tint.
8½-11½" Black sand.
11½-16" Black sand mixed with rusty brown sand.
16"- Yellow sand somewhat iron-stained.

75 W.—Hough Series.

Geology : Basement Beds. Keuper. Origin : Sedentary and some colluvial.

Colour : Grey. Topography : Sloping. Drainage : Good.

Profile : 0-3" Grey sandy loam with iron-stained roots.
3-28" Reddish-brown with greyish tint sandy loam, and clay fraction increases with depth.
28-36" Reddish-brown clay with sand.
36"- Red sandstone.

81 W.—Frankby Series.

Geology : Basement Beds. Origin : Sedentary.

Colour : Greyish-brown. Topography : Slight slope. Drainage : Fair.

Profile : 0-10" Light greyish-brown very fine sandy loam to silty loam becoming slightly lighter in colour downwards.
10-18" Dark rusty red sand with black particles.
18"- Iron-stained sandstone.

79 W.—Haddon Series.

Geology : Basement Beds. Origin : Sedentary.

Colour : Greyish-black. Topography : Flat. Drainage : Fair.

Profile : 0-6" Greyish-black sand with very bleached grains.
6-13" Bleached sand layer.
13-15" Black sand.
15-16" Rusty red sand—deep colour.
16"- Sandstone.

100 W.—Thornton Series.

Geology : Waterstones. Origin : Sedentary.
Colour : Light Brown. Topography : Gentle slope to West. Drainage : Fairly good.
Profile : 0-18″ Light brown fine sandy loam, iron-stained roots, becoming lighter brown loam.
18″- Sandstone.

105 W.—Hough Series.

Geology : Waterstones. Origin : Sedentary and some colluvial Waterstones material.
Colour : Chocolate-brown. Topography : Gently sloping to North-west. Drainage : Good.
Profile : 0-24″ Chocolate-brown fine sandy loam with white grains, passing into very fine sandy loam with a reddish tint.
24″- Sandstone.

101 W.—Neston Series.

Geology : Waterstones. Origin : Sedentary.
Colour : Brown. Topography : Flat. Drainage : Fairly good.
Profile : 0-3″ Brown fine sandy loam with a few white grains.
3-16″ Very fine sandy loam—slightly lighter brown, passing into loam, then silty loam, with a slight reddish tint.
16-34″ Reddish-brown silty loam, slightly bleached, passing into reddish-brown sandy clay.
34″- Yellow sand, slightly iron-stained, passing into sandstone.

98 W.—Greasby Series.

Geology : Waterstones. Origin : Sedentary.
Colour : Fairly dark brown. Topography : Slight slope. Drainage : Somewhat impeded.
Profile : 0-3″ Dark brown very fine sandy loam.
3-16″ Lighter brown fine sandy loam with iron-stained roots, passing into loam, then silty loam and becoming slightly reddish in colour.
16-19″ Reddish-brown silt loam.
19-30″ Reddish-brown sandy loam with iron accumulation.
30-35″ Putty-coloured sandy clay with rusty iron stains.
35-40″ Rusty iron-stained sand and clay.
40″- Sandstone.

82 W.—Arrowe Series.

Geology : Keuper Red Marl. Origin : Sedentary.
Colour : Brown. Topography : Slight slope. Drainage : Good.
Profile : 0-8″ Brown sandy loam.
No CO_2 evolved with hydrochloric acid.
8-16″ Reddish-brown silty loam.
16-18″ Iron-stained silty loam.
18″- Reddish-brown sand.

83 W.—IRBY SERIES.

Geology: Keuper Red Marl. Origin: Sedentary.

Colour: Brown. Topography: Flat. Drainage: Good.

	Profile: 0-2½″	Greyish-brown loam.
No CO_2 evolved with hydrochloric acid.	2½-11″	Lighter brown with light-coloured sand grains, very fine sandy loam to fine sandy loam with iron-stained roots.
	11-18″	Darker brown slightly iron-stained fine sandy loam.
	18-30″	Reddish-brown silty clay loam.
	30-50″	Reddish-brown silty clay loam with some black particles.
	50-54″	Greyish-white silty loam with very small stones.

53 W.—POULTON SERIES.

Geology: Boulder Clay. Origin: Sedentary and some colluvial.

Colour: Greyish-brown. Topography: Gentle slope. Drainage: Slightly impeded.

Profile:
- 0-11″ Greyish-brown sandy loam becoming lighter colour with depth—clay fraction increases.
- 11-15″ Greyish-brown sandy loam—slightly iron-stained.
- 15-26″ Yellowish-reddish-brown fine sand with greenish-yellow and red iron stains.
- 26-41″ Brown iron-stained sand.
- 41-54″ Reddish-brown sand passing into soft sandstone.

45 W.—BARNSTON SERIES.

Geology: Boulder Clay. Origin: Sedentary.

Colour: Light greyish-brown. Topography: Flat. Drainage: Fair.

Profile:
- 0-9″ Light greyish-brown sandy loam, with iron-stained roots and white sand grains.
- 9-18″ Pale brown sand—not appreciably iron-stained.
- 18-36″ Reddish-brown sandy clay with black particles—also small whitish patches.
- 36-54″ Reddish sand with greenish-yellow, whitish and reddish-brown patches, also rounded pebbles.

57 W.—STORETON SERIES.

Geology: Boulder Clay. Origin: Sedentary.

Colour: Brown. Topography: Flat. Drainage: Slightly impeded.

Profile:
- 0-8″ Brown sandy loam—very slight rusty roots, passing into lighter brown sandy loam.
- 8-25″ Rusty yellow clay passing into reddish-brown clay with black particles and whitish patches.
- 25-36″ Reddish sand—brown iron stains.
- 36-54″ Reddish-brown sandy clay with black particles. Faint greenish-grey patches.

69 W.—HADDON SERIES.

Geology : Boulder Clay. Origin : Sedentary.
Colour : Black. Topography : Flat. Drainage : Fair.
Profile : 0-9″ Black sandy loam.
9-11″ Bleached sand.
11-16″ Sand cemented together with iron oxides.
16″- Red sandstone.

72 W.—CLATTERBRIDGE SERIES.

Geology : Boulder Clay. Origin : Sedentary, and some colluvial.
Colour : Greyish-brown. Topography : Gently sloping towards Raby Mere. Drainage : Impeded.
Profile : 0-5″ Greyish-brown fine sandy loam with iron-stained roots.
5-13″ Greyish-white bleached layer becoming more bleached.
13-18″ Very heavily iron-stained rusty brown sand.
18-23″ Light yellowish-brown sand.
23-26″ Reddish sand with bleached patches and iron stains.
26-54″ Reddish-brown sandy clay—many black particles.

68 W.—BRIMSTAGE SERIES.

Geology : Boulder Clay. Origin : Sedentary.
Colour : Almost black. Topography : Flat. Drainage : Impeded.
Profile : 0-8″ Almost black sandy loam with white sand grains.
8-9″ Very heavily iron-stained sand.
9-13″ Very sharp change to bleached sand—slightly iron-stained.
13-40″ Heavily iron-stained clay mixed with red sand and some greenish-yellow patches.
40-44″ Red sand.
44″- Sandstone.

10 W.—HADDON SERIES.

Geology : Shirdley Hill Sand. Origin : Sedentary.
Colour : Greyish-black. Topography : Flat. Drainage : Impeded.
Profile : 0-10″ Greyish-black sand with roots.
10-15″ Bleached sand layer.
15-18″ Dark black sand.
18″- Light yellow sand.

SUMMARY OF SOIL SERIES.

1. HADDON .. .. Upper Mottled Sandstone, Bunter Pebble, Basement, Boulder Clay, Shirdley Hill Sand.
2. CLATTERBRIDGE .. Boulder Clay.
3. STORETON .. Boulder Clay.
4. BARNSTON .. Boulder Clay.
5. POULTON .. .. Boulder Clay.
6. IRBY .. .. Keuper Marl.

7.	ARROWE ..	.. Keuper Marl.
8.	FRANKBY ..	.. Basement Beds.
9.	HOUGH ..	.. Bunter Pebble, Basement, Waterstones.
10.	BRIMSTAGE	.. Bunter Pebble, Boulder Clay.
11.	NESTON ..	.. Bunter Pebble, Upper Mottled Sandstone, Waterstones.
12.	NESS ..	.. Bunter Pebble, Upper Mottled Sandstone.
13.	THORNTON	.. Bunter Pebble, Waterstones.
14.	GREASBY ..	.. Waterstones.

The typical profiles of this region have been described, and they are arranged in the order of geological formation.

Trias {
Keuper—Keuper Marl—Red Marl.
Waterstones—Red Sandstone with Marls.
Basement Beds—Red and yellow Sandstones.
Bunter—Upper Mottled Sandstone—Soft red and yellow Sandstone.
Pebble Beds—Pebbly red Sandstone.
Lower Mottled Sandstone—Soft red Sandstone.

Recent.—Boulder Clay.—Glacial deposit and Shirdley Hill Sand.

We begin with the Pebble Beds of the Bunter, the Lower Mottled Sandstone not being exposed. Very few profiles are described on some formations because their outcrops cover such a small area, and considerable parts of the Wirral Peninsula are now covered with housing estates. Fourteen soil series have been identified, and the same profile is found in some cases on a number of formations. The soils formed on the Bunter Pebble Beds, of which six series have been described, range from examples such as 29 W of the Thornton Series to 62 W of the Haddon. The Thornton Series is a brown sandy loam overlying the sandstone, and there is very little colour or texture change in the profile. In the Hough Series there is a distinct illuviated horizon of clay with a reddish colour. The horizonation becomes more marked in the Ness Series; and in 37 W, 0-22" is the eluviated horizon, 22-24" being the illuviated, marked by the accumulation of iron compounds. In the Neston Series, there is a marked horizon of iron accumulation and also a considerable increase in the clay fraction in the lower part of the profile. In the Brimstage Series, the second horizon is heavily iron-stained, the uppermost being brown or dark brown, with no suggestion of a marked removal of iron compounds. The illuviated horizon, however, is followed by a leached one which is succeeded by another of accumulation, in this case iron compounds. Finally the Haddon Series has the most marked horizonation of the profiles described. The horizons of eluviation and illuviation are clearly seen, and considering 24 W, 0-7" consists of the accumulation of organic matter, 7-11" a leached horizon and 11-22" the horizons of illuviation.

Turning to the Upper Mottled Sandstone, this is not so widely exposed in the Wirral. Three of the series so far described have been identified, the Ness, Neston and Haddon, but no new ones. On the Basement Beds, three series have been identified, the Hough, Haddon and Frankby, the latter not being found on the previous formations. Four series have been found on the Waterstones, the Thornton, Hough, Neston and Greasby, the latter being formed on this formation only. There is very little Keuper Marl exposed, and two series not found on the other formations have been identified.

The soils on the sandstones are still largely cultivated and were no doubt cultivated still more in the past, so that we cannot expect to find many undisturbed profiles. However, on the Bunter Pebble Beds, Upper Mottled Sandstone and Basement Beds, land with pine woods or covered with bracken and gorse occurs, and under this we find very good examples of typical podsols. They are Iron Podsols, and in most cases the upper layer of illuviation consisting largely of black humus is well differentiated from the lower horizon in which the iron is accumulated ; and although the iron is distributed through the whole of the illuviated horizon, the humus accumulation ends abruptly, being followed by a bright orange-coloured sand. It is thus quite clear that on these beds the soil developed under natural conditions is an Iron Podsol, both the geological material and the climate being suitable for its formation. But there are not a great number of podsols as fully developed as those of the Haddon Series. In all probability, all the other series described on these formations represent altered podsols. There are various reasons for the change. Removal of the native forest covering leads to erosion of the upper horizon, which may be removed by wind erosion, by the action of streams of water, etc., and thus exposing either the lower eluviated horizons or the illuviated. If the latter be exposed and cultivated, a soil of almost uniform colour down to the parent material will be obtained. Aeration of the soil will aid the decomposition of the organic matter, and the growth of plants will help to restore to the surface the material which has been leached and otherwise removed to lower horizons. Cultivation may thus help to convert a typical podsol into a soil which, as far as colour profile is concerned, resembles the Brown Earths. The extreme case of this change to a soil resembling a Brown Earth is well illustrated by the Thornton Series. We should thus expect to find soils ranging from typical podsol profiles through those in which various changes have been made by cultivation to this extreme case, the Thornton Series, and this is found to be true. Usually there are clear signs of podsolization in the soils of these Triassic sandstones, and the gradation is well illustrated by the soil series of the Bunter Pebble Beds.

In the Hough, the reddish colour due to the iron in the illuviated horizon is noticed and this is more marked in the Ness and still more in the Neston, but it is only in the Haddon that the bleached layer of the eluviated horizon is really clear. It is suggested that the Brimstage Series has by erosion lost its eluviated horizons ; podsolization has commenced again, so that we have a bleached horizon with those of iron accumulation above and below it. The Frankby Series is another example of a truncated podsol ; and here the upper humus horizon of illuviation seems to form the surface of the present soil, and it is now showing faint signs of podsolization. Immediately below this humus horizon is one that is heavily iron-stained, also containing a considerable amount of humus.

A well-developed podsol has not been found on the Waterstones. There are only two small outcrops, and a considerable part of one of these is covered with houses and the remainder is chiefly arable. The Neston Series is the most podsolized. It is probable that the Greasby Series has some Boulder Clay mixed with it, and there are signs of podsolization. The soils of the Keuper Marl are not calcareous as in Somerset (Low, 1932), but the lower horizons of the Irby Series closely resemble in appearance those of the Coxley. The reaction of these soils, however, is different (see Table 5). It must be borne in mind that the Triassic deposits of Cheshire are not close to limestone rocks as in Somerset, so that the formations do not necessarily correspond chemically and consequently give a different soil. The Arrowe Series is very similar to the Ness and might well be put with it. Very little Keuper Marl is exposed and no podsols of the Haddon Series have been found.

The Boulder Clay frequently contains sandy beds, and it has been assumed that where sandstone or sand is found, this is a deposit formed at the same time as the Boulder Clay, but this is merely for convenience, and it seems probable that many of the geological boundaries are not quite correctly drawn. The Boulder Clay itself is a dark reddish-brown colour, having the texture of a clay, but containing many sand grains. As with the sandstone of the Trias, a number of series are formed on the Boulder Clay. The Poulton, Haddon and Brimstage have sand or sandstone as the lowest horizon examined and the first resembles closely the Neston Series. There are, however, three series which have Boulder Clay for the lowest horizon—the Barnston, Storeton and Clatterbridge. The Barnston shows signs of podsolization with white sand grains in the uppermost horizon, and an illuviated horizon containing black particles of limonite. The eluviated horizon is more clearly defined in the Storeton Series, and also the iron accumulation, whilst the Clatterbridge Series is a well-developed podsol. Fields in which the soil belongs to this series are fairly readily detected, the grass being very poor.

The climate of the Wirral does not differ greatly from that of Central Somerset, but whereas podsols are developed everywhere in the former district, in the districts studied in the latter region soils belonging to the Brown Earths and associated groups (Rendzina and Terra Rossa) are found. But there is an exception in the Somerset region, the soils developed on the Burtle Beds being good examples of podsols. The study of the field characters of the soil type in these two regions having a similar climate illustrates very clearly the importance of the geological material in determining the character of the soil in England. The climate is not sufficiently extreme to be the dominant factor in determining the soil type, but, given the same parent material from a chemical point of view, i.e. a sand consisting largely of silica, the same soil is developed in Somerset and Cheshire. But if the chemical difference is great, then the soil types are quite different. The value of the Geological Survey Maps is very well illustrated by this work, the soil boundaries usually corresponding with the geological. In the Somerset region (Low, 1932) the Penarth rocks consist of a large number of very thin beds, differing considerably from one another, and it is observed that the soils vary greatly over small areas.

ACKNOWLEDGMENTS.

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CONCLUSIONS.

1. The soils developed in the Wirral Peninsula under woodland are podsols.

2. There are relatively few examples of well-developed podsols because cultivation has caused erosion and other changes in the natural profile.

3. Well-developed podsols are only found under woodland or heath conditions.

4. The geology plays a very big part in determining the soil types formed in Cheshire and in Central Somerset.

TABLE I.

Crop Acreage per 100 acres of land in the Wirral Peninsula, 1925.

Wheat.	Oats.	Rye.	Potatoes.	Other Roots.	Temporary Grass.	Permanent Grass.
2·1	12·4	—	4·4	4·0	16·7	58·3

TABLE 2.

Number of Animals per 100 acres of land in the Wirral Peninsula, 1925.

Dairy Cattle.	Other Cattle.	Sheep.	Pigs.
17·18	10·6	33·3	7·6

TABLE 3.

Normals of Monthly Rainfall, 1881-1915 (Air Ministry).

Month.	Cheshire—Birkenhead, Bidston Observatory. 188 ft. 53° 24′ N, 3° 4′ W.	Cheshire, Hoylake (District Council Office). 30 ft. 53° 24′ N, 3° 11′ W.
	in.	in.
January	2·12	2·28
February	1·68	1·70
March	1·90	1·85
April	1·63	1·61
May	1·90	1·89
June	2·20	2·09
July	2·59	2·45
August	3·08	2·92
September	2·41	2·42
October	3·27	3·33
November	2·50	2·75
December	2·65	2·82
Year	27·93	28·11

TABLE 4.

Normals of Monthly Temperature, 1921-1930 (Air Ministry).

T. Hour. Month.	Bidston. 53° 24′ N, 3° 4′ W 198 ft. 18 h Maximum °F.	7 h Minimum °F.	Mean °F
January	45·1	38·1	41·6
February	43·9	36·6	40·3
March	47·4	37·8	42·6
April	50·8	40·6	45·7
May	57·5	45·6	51·5
June	61·9	50·5	56·2
July	65·9	55·0	60·5
August	63·9	53·8	58·9
September	60·6	50·9	55·7
October	54·7	46·3	50·5
November	47·0	39·9	43·5
December	44·4	38·4	41·4
Year	53·6	44·5	49·1

TABLE 5.

Approximate pH Values for some of the Cheshire Soils.

21 W.—NESS SERIES. Bunter Pebble Beds.

	pH.
0-8″	7·25
8-16″	7·25
16-24″	7·25
24-27″	7·25

85 W.—NESS SERIES. Upper Mottled Sandstone.

	pH.
0-8″	5·75
8-16″	7·25
16-21″	6·50
21-23″	6·50

60 W.—CLATTERBRIDGE SERIES. Boulder Clay.

	pH.
0-8″	6·00
8-16″	6·25
16-19″	7·00
19-28″	7·50
28-35″	7·25

30 W.—HADDON SERIES. Boulder Clay.

	pH.
0-8″	5·75
8-12″	6·00
12-21″	6·50
21-40″	7·50

83 W.—IRBY SERIES. Keuper Red Marl.

	pH.
0-2½″	5·75
2½-11″	5·75
11-18″	6·25
18-30″	7·25
30-50″	8·00
50-52″	8·00

79 W.—HADDON SERIES. Basement Beds.

	pH.
0-6″	5·00
6-12″	5·00
12-17″	5·50
17-18″	5·00

76 W.—FRANKBY SERIES. Basement Beds.

	pH.
0-8″	6·25
8-13″	6·50
13-15″	7·00

24 W.—HADDON SERIES. Bunter Pebble Beds.

	pH.
0-3″	5·00
3-9″	4·50
9-15″	5·50
15″-	5·00

105 W.—HOUGH SERIES.

	pH.
0-8″	5·50
8-16″	5·75
16-24″	6·25

These values have been determined colorimetrically.

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METEOROLOGICAL OBSERVATIONS, 1982

EXTRACTS FROM METEOROLOGICAL OBSERVATIONS AT WYE, 1932.

By J. L. HUNT, Dip. Hort. (Wye).

Month.	Air temperature in screen.		Rainfall (inches).	Bright Sunshine (hours).
	Maximum (Mean) °F.	Minimum (Mean) °F.		
January	47·7	36·1	2·28	51·8
February	42·0	31·6	0·74	82·7
March	47·5	32·5	1·57	145·0
April	51·5	38·6	2·51	131·0
May	59·7	43·3	2·80	131·8
June	66·0	47·4	1·08	200·2
July	70·2	52·8	4·00	164·8
August	75·0	55·0	1·19	218·2
September	65·5	49·9	2·42	115·7
October	55·4	41·0	7·78	93·6
November	49·3	38·1	1·32	52·8
December	46·6	36·1	0·49	53·4
	56·3	41·8	28·18 (Total).	1,441·0 (Total).

Extremes for 1932 :

Highest maximum air temperature in screen—89° F., on 19 August.

Lowest minimum air temperature in screen—16° F., on 1 January.

INFLUENCES ON THE QUALITY OF WOOL

By N. L. Tinley, N.D.A.

Lecturer in Agriculture, South-Eastern Agricultural College, Wye.

Each breed of sheep produces wool of a number of different grades and a consignment of wool as it leaves the farm contains wool of several qualities. Most woollen mills to-day produce one type of goods only and so require only one quality of wool, any other quality being comparatively useless to them. Thus mixed consignments of wool are not in such demand as graded consignments or as foreign wools, which do not as a rule show such a wide variation of quality.

During recent years the practice of marketing wool through a co-operative marketing society has become much more common. The duty of these societies is to grade consignments of mixed wool, bale the wool according to its quality and offer it for sale on the London wool market in correctly graded lots. In this way there is more competition for the wools concerned than is the case when the wools are offered for sale in mixed lots. The wool is graded by eye and touch, according to the diameter of the fibres, the length of the staple, the strength of the fibre, the expected yield of the wool when scoured, the colour and, in certain cases, the lustre.

The writer has had the opportunity of examining the grading of 3,000,000 lb. of Kent or Romney Marsh wool, which was handled by the Kent Woolgrowers Ltd. Column 1 of Table I gives the grades into which the Society's grader sorts the wool and Column 2 shows the corresponding Bradford grades ; the length of the staple of these grades is shown in Column 3 and the diameter of the fibre in Column 4. C1 and C2 (50's Bradford Quality) are the finest and OG2 (36's Bradford Quality) are the coarsest grade wools.

Table I.

Kent Woolgrowers Grade.	Bradford Quality.	Length of Staple.	Diameter of Fibre.
C1, C2	50's	Short	1/795"
C3, C4, C5 — 1 in diagrams..	48's-50's	Short	1/744"-1/795"
C6, C7, C8 — 2 in diagrams..	46's-48's	Short	1/696"-1/744"
C9, C10 — 3 in diagrams..	48's	Long	1/744"
C12, C13, C14 — 4 in diagrams..	46's	Long	1/696"
C15, C16 — 5 in diagrams..	44's	Long	1/648"
LG, OG1, OG2 — 6 in diagrams..	44's, 40's, 36's	Long	1/648", 1/595", 1/470"

Further study showed that consignments of wool from different districts of Kent varied considerably in quality. Three clearly defined districts were selected and the grading of the wool produced on 150 farms in these areas was studied. The areas selected were the Low Weald of Kent, the Romney Marsh and the Chalk Formation, which differ from one another widely in their soils and pastures, and it is hoped that the following short description of them will furnish anyone not familiar with Kent with some idea of the country concerned.

THE LOW WEALD.

The Low Weald is an area of impervious, heavy clay, formed by the outcrop of the Weald Clay. The chief characteristic of the soils is their heaviness. The district is low lying and for the most part flat with poor natural drainage. Most of the land is under

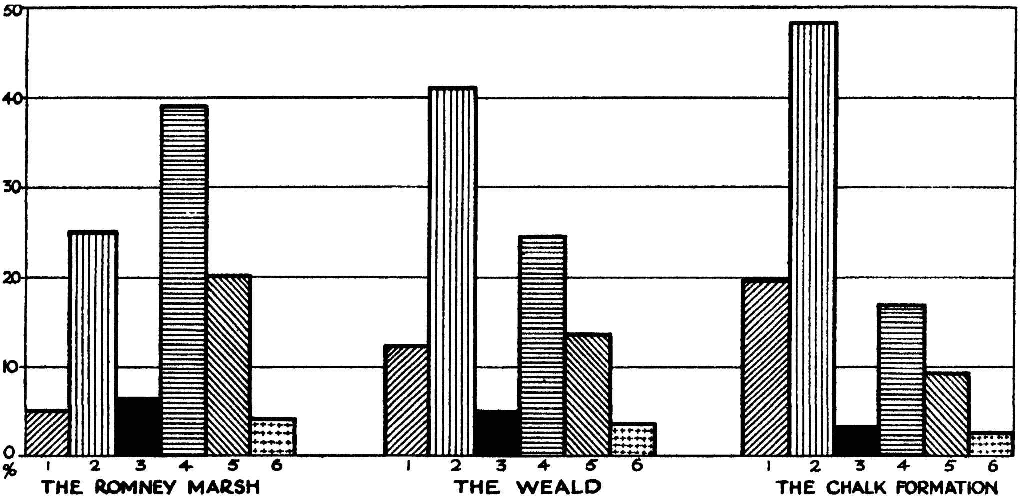

Fig. 1.—The percentage of various grades of Kent Ewe Wool produced on the Romney Marsh, the Weald and the Chalk Formation during 1927, 1928, and 1929. The numbers at the foot of the columns refer to the grades in Table I.

grass, such arable land as there is being cropped chiefly with wheat, oats, beans and mangels. Hall and Russell describe this grassland as being "very poor in character, the herbage chiefly consisting of various forms of Agrostis (bent), Crested Dogstail, Cocksfoot, Yorkshire Fog, with Ryegrass and Rough Stalked Meadow Grass in the better patches."

THE ROMNEY MARSH.

The Romney Marsh is a plain of alluvium and marine detritus, and most of the region is a few feet below the high water line. The superficial layer varies from shingle, covered only in patches by vegetation to a deep rich alluvial deposit, ranging in texture from sandy loam to clay loam. The best pastures rank among the finest in the country, some of them carrying twelve sheep to the acre during the grazing season, but on the other hand some of the grazing is only moderate in quality and some definitely poor. Shelter is scarce, the fields being divided by dykes instead of hedges and most of the land is exposed to the full force of the rain and wind in winter and to the unrelieved glare of

the sun in summer. The area stretches along the coast from Hythe to the River Rother and inland to the Royal Military Canal, being in all over 40,000 acres in extent.

THE CHALK FORMATION.

This area is less clearly defined than the Low Weald or the Romney Marsh. It consists mainly of upland and hills at a height of 500 to 800 feet above sea level. These hills or downs have a steep southern scarp slope and a gradual northern dip slope. Cutting this region are deep valleys, which usually run northwards and most of them are dry. On the top of the hills superficial deposits frequently cover the chalk, they vary in depth from a few inches to as much as 20 feet and range in texture from sandy deposits to quite heavy clays, the latter usually containing flints. The sides of these dry valleys are covered by a very shallow soil and poor vegetation, the majority of which consists of pasture weeds, fine leaved grasses and tor grass. At the bottom of the valleys is a

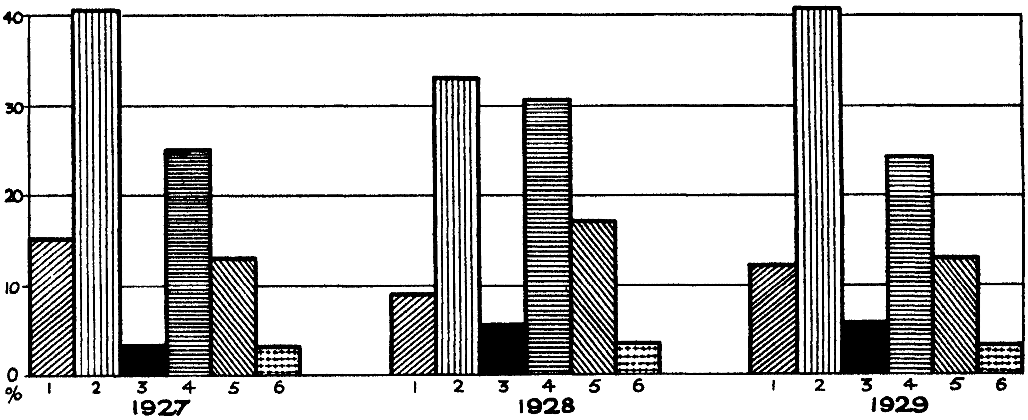

Fig. 2.—The percentage of various grades of Kent Ewe Wool produced during the years 1927, 1928 and 1929. In this diagram the Romney Marsh, the Weald and the Chalk Formation have been taken together. The numbers at the foot of the columns refer to the grades in Table I.

deposit of soil of varying depth, which has washed down from the hills; this varies greatly in texture, but is usually a good soil growing pastures moderate to good in quality.

The percentage of wool of the grades shown in Table I which was produced in the three districts during the years 1927 to 1929 is shown in the diagram on page 156.

From this diagram it will be seen that the percentage of the finer grades of wool produced on the Chalk is double that which is produced on the Romney Marsh and that the reverse applies to the stronger wools. The Low Weald is intermediate between the two districts.

Ewe wool only has been included in this investigation, as the lambs from the Marsh are wintered on the uplands of Kent, Surrey and Sussex and return to the Marsh in the following spring. Their wool, therefore, when they are shorn as tegs, has been produced in two of the districts under discussion, rendering the inclusion of the teg wool inadmissible.

In addition to variation between the three districts, there is variation between the three seasons 1927, 1928 and 1929. In the diagram on this page, which shows the

percentage of the various grades produced in the three seasons, the figures for the Marsh, the Weald and the Chalk Formation have been grouped together. There is no very marked difference between the 1927 and 1929 figures, but in the 1928 clip the percentage of the coarser wools produced was much higher than in the other two years.

Table II gives the rainfall, as recorded at Wye, between June and the following May, the period during which each clip was grown, for the three years under discussion.

TABLE II.

June 1926 to May 1927	27·50 inches
June 1927 to May 1928	37·01 inches
June 1928 to May 1929	23·65 inches

It will be seen that the two years 1927 and 1929 were comparatively dry ones and that 1928 was exceptionally wet. There would thus appear to be a correlation between climate and quality of wool.

DISCUSSION OF RESULTS.

The figures given above show that in the Romney Marsh, a district in which the pasture is thick and lush, a higher proportion of the coarser wools is produced than on the Chalk Formation, where the grass is thin and sparse. The figures also indicate that in wet seasons, which are characterized by the production of a comparatively thick, lush growth of grass, the proportion of wools of a coarser grade is greater than in a dry season, when grass would probably be scarce.

When considered together these two results would appear to be significant and to indicate that a thick, lush herbage tends to encourage the production of wool of a coarser grade than the thin, sparse herbage, which encourages the growth of the finer grades of wool.

ACKNOWLEDGMENTS.

The writer would like to thank Mr. F. C. J. Swainson, Secretary of the Kent Woolgrowers Ltd. for allowing him to calculate the above figures from the books of the Association and also Mr. R. Collins, the Kent Woolgrowers wool grader, for his continued help.

AN EXAMINATION OF THE HYDROGEN-ION CONCENTRATION OF THE SOILS OF THE FARM OF THE SOUTH-EASTERN AGRICULTURAL COLLEGE

By J. K. Dubey, Ph.D. (London), M.S. (Illinois), F.I.C.S. and G. C. Procter,

Department of Zoology and Geology, South-Eastern Agricultural College (University of London), Wye, Kent.

The soils of the College farm were defined and placed in eleven *soil-series* by Brade-Birks and Furneaux (1930) who gave the approximate pH value of the surface soil as determined by I. B. Prowse. The soils have now been examined by the writers for their hydrogen-ion concentration (pH) value by Colorimetric and Quinhydrone methods, and three determinations have been made on *each horizon* of each soil-series, viz. :—

I. pH value of the natural soil, as taken direct from the field, by the colorimetric method.

II. pH value of the air dried soil, by the Quinhydrone method.

III. pH value of air dried soil, by the colorimetric method.

In addition to the examination for pH value, all the soils were tested for effervescence with dilute hydrochloric acid, in order to see if any relation existed between the pH value of the soil and the calcium carbonate (Chalk) material in it.

The apparatus used for the determinations by the colorimetric method was a " soil testing outfit " manufactured by the British Drug Houses, Ltd. In this method, a mixture of equal parts of the indicator supplied by the firm and of the soil solution, is compared colorimetrically with standards representing pH values at intervals of 0·5 units.

The Quinhydrone electrode method used was based on that of Biilmann. Potential differences were taken, as near as possible, at ten seconds after the addition of the Quinhydrone to the soil solution, and the pH values obtained from these potential differences by references to tables. The Quinhydrone electrode method does not function for pH values above 8·5, but appeared to be satisfactory for the soils tested, although the value of some rose as high as 8·25. The chief disadvantage of the method is that the potential difference indicated varies with the time between the adding of the Quinhydrone and the taking of the reading. It has the advantage, however, of showing much smaller variations of pH value than are within the capacity of the colorimetric method.

TABLE I.

Showing Comparison of pH Values of College Soils by Colorimetric and Quinhydrone Methods.

Method Used.	pH Colorimetric on Natural Soil.			pH Quinhydrone on Air Dried Soil.			pH Colorimetric on Air Dried Soil.		
Section.	1			2			3		
Horizon.	A	B	C	A	B	C	A	B	C
Downland Series ..	8·0	8·0	8·25	7·80	7·9	8·00	7·5	7·5	7·5
Sidelands Series	8·0	8·0	8·25	7·78	7·8	8·05	7·5	7·5	7·5
Coldharbour Series ..	8·0	8·0	8·0	7·68	7·72	7·85	7·75	7·75	8·0
Gore Series	8·0	8·0	8·25	7·65	7·77	7·82	7·75	7·75	8·0
Sparks Series	8·0	8·0	8·25	7·46	7·60	7·68	7·75	7·75	8·0
Wye Series	7·5	7·5	7·5	7·60	7·30	7·60	7·25	7·25	7·25
Brices Series	7·25	7·25	7·25	7·60	7·25	7·60	7·25	7·25	7·5
Forstal Series	7·0	7·25	7·25	7·25	7·38	7·42	7·25	7·25	7·25
Sharbrooks Series ..	7·0	7·25		7·02	7·07		7·0	7·25	
Brook Series	7·25	7·4	7·5	7·68	7·7	7·6	7·3	7·5	7·8
Wood Series	7·25	7·25	7·25	7·13	7·32	7·42	7·25	7·25	7·25

Table I shows the soil pH values obtained by all the three estimations. From this it is seen that the deeper one goes into the soil, i.e. the nearer to the rock (which is often Chalk), the greater becomes the pH value and this latter varies between 7·0 and 8·25. It was not expected that any very great differences would occur owing to the small area covered. Even so, however, there were certain points of interest about the differences of pH value observed. The shallower soils, i.e. those in which the rock is nearer the surface, show a higher pH value, and therefore greater alkalinity than the deeper ones. It will be noted that the shallow soils show a pH value of 7·5 to 8·25 and the deep ones 7·0 to 7·5. Brook series shows a higher pH value than the other soils of the same depth, but this may be correlated with geological differences which have not yet been investigated.

The most productive soils are those of greater depth and these happen to be of lower alkalinity. The most fertile soil on the farm, the Wye loam, has a pH value of 7·5.

A comparison of sections 1 and 3 of Table I shows that there is greater variation in the pH value of natural soils than in that of air dried soils, the results in the majority of cases being higher. This greater variation is evidently due to soil moisture.

A comparison of sections 1 and 2 of Table I shows the relation between the pH value by the colorimetric method on the natural soil and that by the Quinhydrone method on air dried soil. Here again the natural soils show more variation and, for the most part, greater alkalinity.

By comparing sections 2 and 3 of Table I it is seen that for the air dried soils the Quinhydrone and colorimetric methods give quite reasonable agreement, the Quinhydrone method giving, if anything, slightly higher figures. The Quinhydrone method shows slight increases in alkalinity as we approach the Chalk, whereas the colorimetric method is in many cases too approximate to show these. In two series, Wye and Brices, the A horizon is found by the Quinhydrone method to have a higher pH value than B horizon, and this slight difference is not shown by the colorimetric method. The

explanation of this higher pH value of the A horizon is, probably, that it is due either to the plants in the soil, or to the manures applied.

TABLE II.

Showing Comparison of Average pH Value with Effervescence with Dilute Hydrochloric Acid.

Method.	Average pH Value.			Effervescence with dilute Hydrochloric Acid.		
Horizon.	A	B	C	A	B	C
Downland Series ..	7·68	7·72	7·92	Strong	Strong	Very strong
Sidelands Series ..	7·76	7·77	7·80	Strong	Strong	Very strong
Coldharbour Series	7·81	7·82	7·95	Strong	Strong	Very strong
Gore Series ..	7·80	7·84	7·82	Strong	Strong	Very strong
Sparks Series ..	7·74	7·78	7·98	Strong	Strong	Very strong
Wye Series ..	7·45	7·35	7·45	Weak	Slight	Slight
Brices Series ..	7·45	7·33	7·33	Weak	Slight	Slight
Forstal Series ..	7·17	7·21	7·39	Medium	Medium	Medium
Sharbrooks Series	7·01	7·19		Very slight	Very slight	
Brook Series ..	7·43	7·53	7·63	Medium	Strong	Very strong
Wood Series ..	7·21	7·24	7·31	Weak	Slight	Very slight

Table II shows that there is a close relation between pH value and effervescence with dilute hydrochloric acid. In all cases a rise in pH value is accompanied by greater effervescence showing that the alkalinity of the soil is due chiefly to the calcium carbonate (Chalk). Even soils which are practically neutral show a very slight effervescence.

CONCLUSIONS.

1. The alkalinity of the soil gradually increases as we get lower in the soil-profile and consequently nearer to the rock (often Chalk).

2. All the soils are either neutral or alkaline.

3. Effervescence with dilute hydrochloric acid increases with rise in pH value.

4. The lower the Chalk material is in the soil-profile the lower becomes the pH value of the various horizons, being as low as neutral in the top horizon, in spite of the fact that the water which moves upwards in summer is bound to bring alkaline material from the unweathered Chalk rock below.

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(2) BIILMANN, E., 1925. "On the measurement of Hydrogen-ion concentrations in the soil by means of the Quinhydrone electrode." *Jour. Agric. Sci.*, Vol. 14, p. 232.

SOIL MONOLITHS

By S. Graham Brade-Birks, M.Sc. (Manchester), D.Sc. (London), and
J. K. Dubey, M.S. (Illinois), Ph.D. (London), F.I.C.S.
Department of Zoology and Geology, South-Eastern Agricultural College (University of London), Wye, Kent.

With the gradual recognition of the soil as a natural object has come also the gradual recognition that for its study first hand information must be obtained from the examination of the soil itself in the field. The experienced worker will find that surface features such as texture, topography and colour can be determined by quite cursory examination especially if this be supplemented by the use of a soil auger. A consideration of the climate and of the local geology (including the mode of deposition of the mineral part of the soil) will add a good deal to his data. From attention to the vegetation, often supplemented by information given by the farmer himself, a knowledge of natural drainage conditions can be obtained. Simple chemical tests will give an index of the reaction of the soil and if all the information thus far obtained be supplemented by an examination of the soil in section the observer who regards the soil as a natural object will have before him all the properties which are necessary for a mental picture of it.

The examination of the soil in section is in effect the most important part of the soil investigator's work for from a section of the soil—the *soil profile* as it is technically called—we can deduce much of the history of the soil, we can determine its place in the world-classification of soils, and learn most of the facts that are of importance in its utilization. When it has been recognized that the study of the soil in a section is very important the investigator naturally looks round for facilities for such a study. In England opportunities are provided in quarries, in sand and gravel pits, in road and railway cuttings and in wells and drainage excavations, and the farmer himself often sees sections of his soils when minor excavations are made on his land in fencing and other operations. Such soil-sections often require some cleaning to exhibit fresh surfaces but they generally provide us with valuable information. From such a study of a large number of soils in any district we not only gather information of great practical value regarding individual soils but often a knowledge of the diagnostic properties of the soils of the region as a whole.

Preparing a Pit.

For the full examination of the *soil profile* it is generally necessary to dig a pit specially for the purpose. This pit will frequently suffice if it be 3 feet by 3 feet in plan and as deep as required to reach the unaltered rock, often this is not more than 4 feet down and sometimes much less (Fig. 4). The pit should not be dug after heavy rains nor when the soil is very moist, or shrinkage will occur in the monolith box.

It is highly desirable for students and investigators of the soils of any region to have ready access to the fullest possible information concerning the soils with which they are dealing, and this is, of course, largely provided by sections exposed in pits kept open for this special purpose, but these cannot be readily available for all soils. Moreover almost all soil sections change more or less rapidly when exposed to the air,

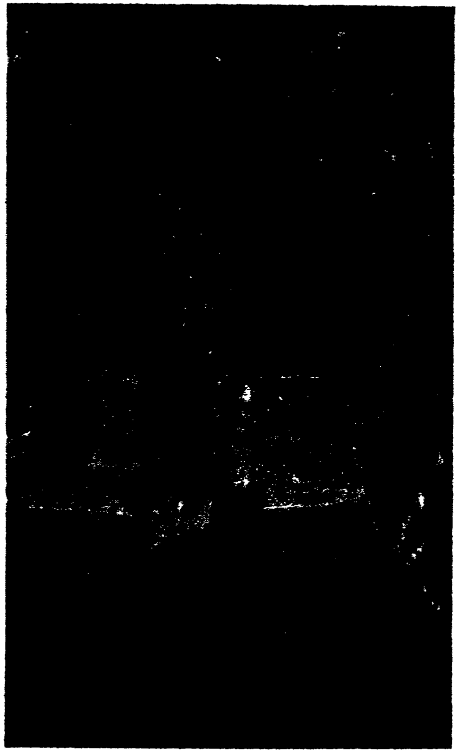

Fig. 1.—The prepared pit. A column for the monolith is seen projecting in the middle of the opposite wall, while at the bottom of the pit there is standing water.

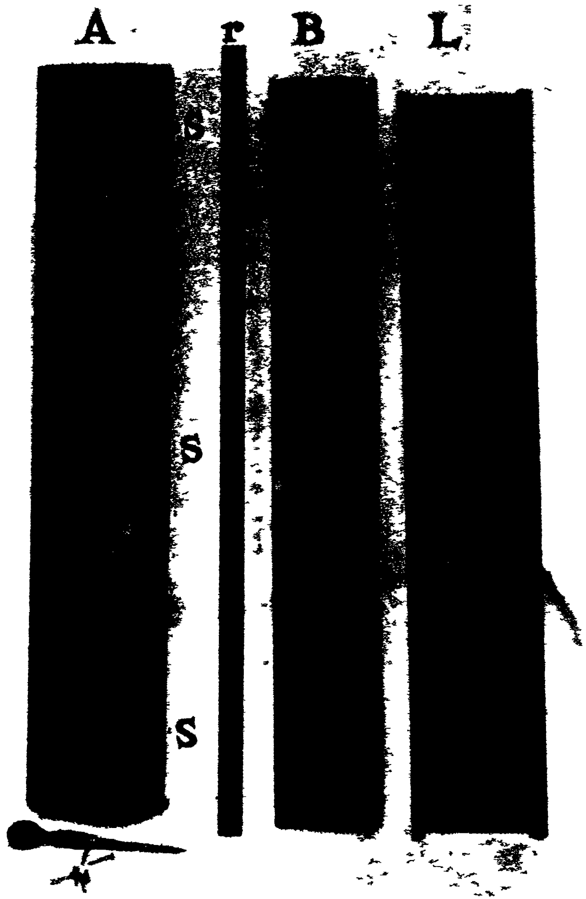

Fig. 2.—Monolith Boxes. On the left is a soil box closed (A), the screws (S) in position but not driven home. Next to this box is a metre rule (r) and then comes an empty box (B) with its detached lid (L).

so that in a continuous study some handy substitute for freshly-dug soil-pits must be sought, especially when the area under study is wide. Such a substitute is provided by a column of soil (called a *soil monolith*) cut out entire and preserved in as natural a condition as possible so that reference can readily be made to it whenever need arises. Such soil monoliths may be preserved in the laboratory in simple wooden boxes specially prepared for the purpose.

Monolith Boxes.

As these boxes are of considerable importance in obtaining really useful monoliths some reference may be made here to their construction. If the soil monolith is to be taken by the method to be described below the inside dimensions of the box need not be more than three-quarters of an inch to 1 inch deep and 2 inches broad, though a 3 inch breadth is preferable as this gives a much better view of the section. If these dimensions are exceeded the monolith and its box tend to be cumbersome but with the dimensions suggested three or four boxes can readily be transported on the luggage carrier of a small car.

The length of the box is, of course, determined by the depth of the soil profile.

The box itself (Fig. 2) is of deal with sides $\frac{5}{8}$ inch thick, bottom and lid $\frac{1}{2}$ inch thick, and ends of elm 1 inch thick. It is of ordinary construction and calls for no special comment. The lid is the same length as the monolith box but $1\frac{1}{2}$ inches wider. The ends of this lid are left without any further addition but along the sides of the lid are screwed fillets of $\frac{3}{4}$ inch square deal which can be screwed into the sides of the box as required. If this be properly made the lid slides smoothly on to the box without disturbing the surface of the monolith, and since the screws are inserted sideways the face of the box is not disfigured by screw holes. Furthermore if it were desired to expose a fresh surface of the soil the box and soil could be sawn through very easily. It would be an advantage to paint the box inside with some waterproofing material to prevent absorption of water by the wood.

In Russia (see Glinka's *Die Typen der Bodenbildung*, 1914, pp. 10-13), in the United States of America and in some other countries soil monoliths have been employed as a permanent record of the soil characters revealed by the study of sections. This procedure eliminates the need for digging pits again or for maintaining permanent pits. In England not much prominence has been given to the methods whereby such soil monoliths are satisfactorily obtained nor do any English pedologists seem to have published details of a method for obtaining them, though a recent paper has given a useful account of a method successfully employed in Canada (F. F. Morwick, 1932, " Preservation of Soil Monoliths," *Scientific Agriculture*, 13, No. 1, pp. 1-6, Sept. 1932). Some soil workers prepare more or less artificial monoliths by taking samples horizon by horizon in bags—an easy method of transport—and arranging these in their natural order in a box, in a thin layer, sprinkling the soil with water to obtain a better result. This method destroys some of the important characters of the soil including some of the structural features which are preserved in a true monolith.

Obtaining a Monolith.

After a *soil-series* has been established, one of the present writers (J.K.D.) has employed a method by which a true soil monolith can be obtained very simply and without much labour. A pit as already described is dug. In the middle of one side wall of this pit and from the top to the bottom, a soil pillar or column 2 or 3 inches wide,

is left projecting 1½ inches (Fig. 1) by scraping off the rest of the material with a spade. All the work can be done by a labourer. The next step is to cut a slot in the pillar so that the lower end of the monolith box, already described, can be slipped into it. The box should now be slipped on to the pillar and gently tapped with the handle of the spade or pressed on tight with a motor car jack (by putting a board at the other end of the pit, adjusting the jack horizontally and then turning the handle). This process permits of

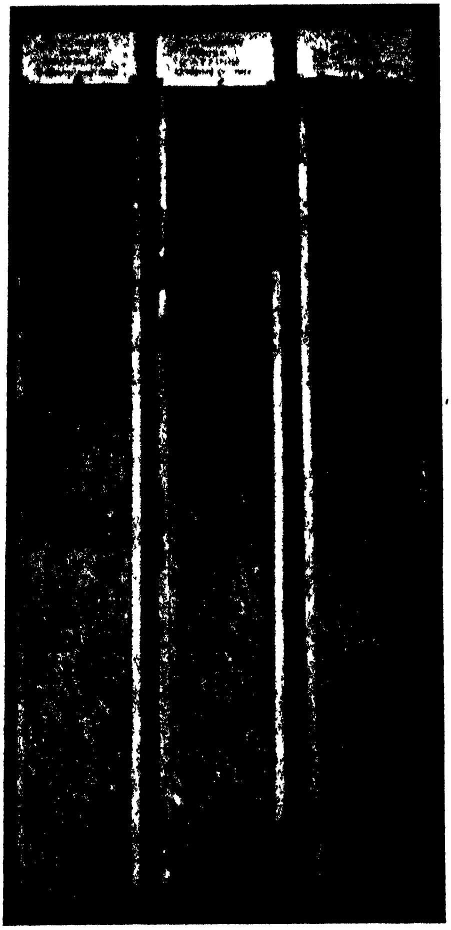

Fig. 3.—Completed soil monoliths in their boxes four feet six inches long. These monoliths of the Newchurch Series, New Romney Series and Finn Series, were taken on the spot and show exactly the soils of various series as they exist in situ.

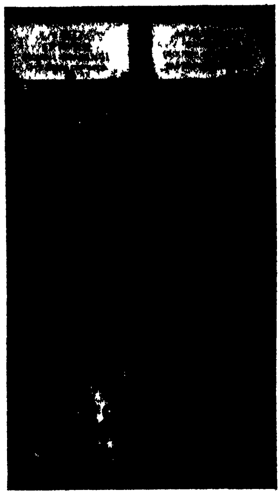

Fig. 4.—On the left a shingle (gravel) soil monolith which was built up artificially and a peat soil monolith on the right taken in situ.

the box being filled tightly. The soil column must now be cut away by means of a saw using either the toothed-edge or the back. Very often the back works better than the toothed-edge. It is important to leave the pillar in the *middle* of one of the walls of the pit, so that the saw can be worked easily. The section may be cut flush with the side of the pit, so that an extra half inch of soil projects from the box. Any small stones which

may be present in the soil will not in this way disturb the boxed sample. In cutting the section the stones can be worked out by moving the saw backwards and forwards as in sawing wood. The box should now be carefully lifted out of the pit, laid flat on the ground, the back of the saw held firmly with both hands and the section cut flush with edges of the box. The cutting of the section should usually be carried out from the bottom towards the top ; the object of this being to avoid smearing light coloured parts of the profile with darker material. In the second cutting it is possible to remove any defects which may have crept into the section while cutting it from the pit where it is impossible to see what is happening. However with experience it is possible to cut many sections flush with the box in one operation.

The whole process does not take more than fifteen to twenty minutes after the pit has been dug by a labourer and perfect soil monoliths can easily be obtained (Fig. 3).

By this means monoliths can be obtained of soils which are sandy (but not of running sands), and from these to very heavy soils, and also of peats, unless the water table is too near the surface. In cases of difficulty with water a spot having a lower water table can usually be located and a monolith taken there. The only soils of which it is difficult to take a monolith are those which contain a very large number of stones. These soils are, however, not usually of much economic importance and in their case the only way to preserve a section is to build up an artificial monolith, as in the case of the Lydd Series illustrated in our photograph (Fig. 4).

Photographing the Pits.—It is an advantage to take a photograph of the pit from which the soil monolith is cut as an additional record. To get a good photograph it is necessary to widen the pit on the side opposite. The best plan is to cut away the side of the pit as a slope to enable the photographer to get a good view of the section to be photographed.

Storing the Monolith.—If it is desired to keep the monolith moist it should be stored in a cool place and may occasionally be sprayed with water, oftener in summer than in winter. If earthworms are present or there is any danger of moulds growing in the soil, then a little disinfectant, such as Formalin, may be added. It has been possible, by this means, to keep monoliths in a perfectly moist and natural condition for several months, but the process is rather tedious.

The best method is to spray the monolith with a water solution of some deliquiscent substance. A 30 per cent solution of zinc nitrate gives excellent results. A 30 per cent solution of calcium chloride has also been used ; but an excess of this substance flocculates clay soils and induces cracking. Among organic compounds ethyleneglycol and commercial glycerine have also given fairly satisfactory results ; in fact any strongly deliquiscent compound which is colourless and *does not react with the soil* will serve the purpose.

The result is that after a single spray the soil maintains a permanent film of moisture and keeps in a perfectly good condition.

If the monolith is to be dried then the edges of the box must be packed stage by stage as the drying of the soil proceeds, to prevent it from cracking in the middle. The last packing should be put in when the soil is thoroughly dry and the monolith is ready to be stored.

CONCLUSIONS.

1. The method described provides a rapid way of obtaining a monolith.

2. The method is quite simple. No implements other than a box, a saw and a spade are required.

3. The weight of the monolith does not exceed a few pounds.

4. Important structural features of the soil are satisfactorily maintained.

5. Monoliths can be kept permanently moist by the addition of deliquiscent substances, such as a 30 per cent solution of zinc nitrate.

6. Monoliths can be dried without any cracking or destruction of horizonal features if the packing of the box is properly carried out.

ACKNOWLEDGMENT.

We thank Dr. W. Goodwin, Head of the Research Department of Chemistry in this College, for kind suggestions with regard to deliquiscent substances.

A NOTE ON *LYGUS PABULINUS* L.

By M. D. Austin, F.R.E.S.

Department of Entomology, South-Eastern Agricultural College.

By now it is well known that the Common Green Capsid (*Lygus pabulinus* Linn.) has a very wide range of host-plants during the summer ; these have been noted by various writers. Petherbridge and Thorpe (1928) record a variety of plants on which the immature bugs have been found ; Steer (1929), Walton and Staniland (1930) and the present writer (1931) also refer to certain host-plants of this pest. In the main the wide range of host-plants noted is in connection with migrants of the first generation and also of the second generation. During the autumnal oviposition period the bugs confine themselves to plants of a woody nature, such as currant and apple.

The selection of a woody plant, or at least one with a permanent aerial portion, however small, for ovipositing purposes, is imperative if the over-wintering eggs are to survive through the comparatively long period in which they remain in the plant tissues. Oviposition, during the late autumn, within the tissues of herbaceous and other weeds including such plants as Groundsel would inevitably lead to the destruction of the eggs when the plants die off; over-wintering eggs are not known to be laid in such plants in this country.

The presence of the over-wintering eggs within currant and apple wood makes it possible to attempt to control capsid through the medium of ovicidal winter washes of the petroleum type. By this means a certain amount of successful control has been obtained. It is obvious that with the insect under review (especially when its spring migration is borne in mind) winter control is to be preferred to measures involving spring and summer sprayings with nicotine. To obtain maximum efficiency from the use of spring washes they must be applied within the period demarked on the one hand by the extent of the hatching period and on the other hand by the commencement of the spring migration of the immature bugs to other plants. Accurate timing of the application of the wash is essential, and bearing in mind that other factors such as weather may narrow down the available time for this purpose it would seem that control of this pest is more conveniently attempted during the winter.

However, of late years *L. pabulinus* appears to have been less selective of its host-plant for the oviposition of its over-wintering eggs and it does not seem to confine itself to apple, currant and gooseberry for this purpose. This statement is supported by recent experience at Wye. Some years ago a plentiful supply of eggs could invariably be found in red currant twigs. In the winter of 1930-31 this was evident from examination of a large number of such twigs, but during the winter of 1931-32 the eggs were less prevalent and by the winter of 1932-33 they were still less plentiful at this source. This marked decrease could not reasonably be attributed to control measures in use during the summer previous to each of the seasons referred to, because field observations had shown that, if anything, *Lygus* was increasing.

Other observations made during the seasons concerned showed an obvious and steady increase in attacks of *Lygus* on cultivated blackberry. Hitherto these attacks were attributed to the migrants from currants nearby. However during the spring of 1932 it was evident that attacks commenced before the migration of the young bugs occurred. It was considered probable that some over-wintering eggs had been present in this plant.

Examination of badly attacked cultivated blackberry plants in the College plantations during the winter of 1932-33 brought to light numerous eggs agreeing with those of *L. pabulinus* Linn. The same technique as that described by the writer (1929) for finding the eggs of *Plesiocoris rugicollis* Fall. and *Lygus pabulinus* L. in apple and currant shoots was followed to expose the eggs in the blackberry shoots. It was found, however, that the eggs are, to some extent, visible from the outside of the shoot. The oviposition puncture can often be plainly seen as a discoloured (slightly whitish-grey) area and the outline of the flask-shaped body of the egg is frequently visible as a slightly

Fig. 1.
× approx. 8.

Fig. 2.
× approx. 8.

raised portion of the epidermis of the shoot. The caps of the eggs are also fairly easy to observe; the nature of the epidermis of the shoot, i.e. smooth and without masses of hairs (as is often found with apple shoots) makes the discovery of the eggs quite easy.

The eggs are usually deposited rather shallowly in the epidermis and not inserted deeply in the wood itself, but they are, nevertheless, entirely embedded with the exception of the caps. Careful peeling of the epidermis is therefore necessary to expose the eggs which are invariably laid with their concave side facing the apex of the shoot. Two eggs thus exposed are shown in Fig. 1, and the surface view of oviposition punctures and the caps of two eggs are shown in Fig. 2. These eggs are usually laid in the new growth of the blackberry but have been found in older portions of the plant.

It is not suggested that it is unusual for *L. pabulinus* to lay its over-wintering eggs in blackberry shoots but there is reason to suppose that it is of more common occurrence than formerly. It is of interest to note that Petherbridge and Thorpe (op. cit.) after mentioning that the over-wintering eggs of this bug are laid in currant, gooseberry and apple shoots state " They are also probably laid in plum suckers, and the shoots of pears, cherries, rose, raspberry, *Ribes aureum*, lilac, hawthorn and snowberry (*Symphoricarpus*), as first stage instars are found on these early in the season. . . . We also regard the blackberry as a probable winter host, as this plant is attacked by both generations and is largely used as a food plant by the second generation adults. Careful search failed to reveal any autumn eggs on herbaceous plants, the return to woody plants for this purpose being complete." These writers mention in a footnote to the same paper that they later found eggs in rose plants. That the range of winter host-plants is still wider is shown by Hey (1932) who records the presence of over-wintering eggs in strawberry.

The importance of additional winter host-plants of *Lygus pabulinus* is here mentioned for at least two reasons. Firstly the presence of eggs of injurious capsids over-wintering in the tissues of plants other than apple, currant and gooseberry, especially in mixed plantations, is an obvious source of danger to other fruit trees and bushes as well as to other crops. If it is assumed that the usual ovicidal washes cannot be applied to blackberry bushes during the winter, trouble is certain to follow in the spring. Secondly there is some danger of serious attacks of *Lygus* occurring on the blackberry bushes in the early part of the season which may entail special spring and summer sprayings on this crop.

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A BRIEF REVIEW OF THE RESEARCHES ON THE ACUTE DISEASES OF SHEEP ON THE ROMNEY MARSH

By A. D. McEwen, B.Sc., M.R.C.V.S.
Veterinary Laboratory.

"Struck."

The investigations of the first year, 1930, have already been summarized in this *Journal*, McEwen (1931) and reported more fully elsewhere, McEwen and Roberts (1931). As a result of these researches it was considered that a specific disease of sheep occurred on the Romney Marsh and the popular name "struck" was retained for this disease. During the 1930 season, forty cases regarded by the owners or shepherds as examples of "struck" were post-mortemed and detailed bacteriological examinations made. Thirty of these were found to have been affected by the specific disease. The remainder showed a variety of pathological conditions but failed to show evidence of the presence of any contagious disease.

The examination of the thirty cases of the specific disease showed that definite and pathognomonic lesions were present at the time of death and that characteristic post-mortem changes occurred in the muscular and subcutaneous tissues after death. Before death or at the time of death, there was generally a slight invasion of some of the body fluids and tissues with a bacterium belonging to the *Bacillus Welchii* group, namely, *B. paludis*, McEwen (1930), but in a number of instances the body fluids and tissues were sterile. The changes in the subcutaneous and muscular tissues were shown to be due to the post-mortem multiplication of *B. paludis* in these tissues.

The disease with its lesions was produced by feeding sheep with very large quantities of broth cultures of *B. paludis*, and towards the latter end of the season it became evident that this micro-organism played a most important part in the causation of "struck" even although in some cases it was not present in the body during illness or even at the time of death. *B. paludis* produces a potent exotoxin and it was considered probable that this toxin injured the mucosa of the intestine, and, becoming absorbed, caused toxaemia and death. Search was accordingly made for this toxin in the alimentary canal of sheep. Only three suitable cases were obtained for this work, but in two instances *B. paludis* toxin was identified. The hypothesis of the absorption of toxin from the contents of the alimentary canal was therefore strongly supported by indirect evidence.

It is interesting to note that the disease lamb dysentery shows many similarities to "struck." The Lamb Dysentery bacillus is very closely related to *B. paludis*, producing a comparable toxin, and lamb dysentery is a disease of alimentary origin. Controversy had centred round the part played by bacteria in this disease. The Lamb Dysentery bacillus had been isolated from affected lambs and demonstrated in ulcers in the intestine, further lambs immunized against the Lamb Dysentery bacillus toxin have been shown to be protected against the disease, Dalling (1930). However, careful work

on cases obtained at the time of death, had shown that in the absence of ulceration the body tissues were sterile and that the primary lesions of lamb dysentery were a necrosis of the villi of the small intestine with petechial haemorrhages and ecchymoses of that organ and that these were not associated with a bacterial invasion of the tissues, Hare and Glynn (1927). It was pointed out, McEwen (1932) that any apparent incompatibility in the views regarding lamb dysentery was overcome if a similar hypothesis to that suggested regarding the aetiology of " struck " were accepted, namely, that the Lamb Dysentery bacillus multiplied in the intestine, produced toxin, that the toxin injured the mucosa of the intestine, became absorbed and caused toxaemia and death. Montgomerie (1932) reported that lamb dysentery could be diagnosed by examining the contents of the intestine for toxin and thereby contributed support to the suggestion that it was a toxin from the alimentary canal that was the primary cause of disease. A similar explanation of the aetiology of a disease of sheep in Western Australia was given by Bennetts (1932) who had carried out investigations for several years on a braxy-like disease of sheep and concluded that it was not caused by bacterial invasion of the tissues but by absorption of the toxin of a bacillus he named *B. ovitoxicus*, which multiplied and produced its toxin in the small intestine. Bennetts succeeded in reproducing the disease when he fed quantities of the bacillus to sheep previously dosed with opium and belladonna. He considered that this treatment by producing stasis of the bowel permitted suitable conditions for the growth of the bacillus and suggested that a stasis of the bowel probably had occurred in sheep affected in the field. Sheep, however, get the disease when grazing on succulent green food and it seems doubtful whether bowel stasis is likely to occur under such conditions. Bennetts called the disease " infectious entero-toxaemia " and this disease and " struck " on the Romney Marsh are aetiologically very similar, both being caused by bacteria of the *B. Welchii* group. Still more recently Oxer (1932) in Tasmania and Gill (1932) in New Zealand working on pulpy kidney disease in lambs, concluded that absorption of bacterial toxin from the intestine was the cause of death. In Tasmania *B. ovitoxicus* and in New Zealand a similar micro-organism are the responsible bacteria. Montgomerie and Rowlands (1931) had found that in cases of pulpy kidney disease in North Wales, there was a potent toxin in the intestinal contents and considered that this was probably responsible for the condition.

Evidence had therefore been accumulating to show that disease of sheep and lambs is caused by a bacterial toxin derived from the contents of the small intestine and in all these diseases, " struck," lamb dysentery, infectious entero-toxaemia and pulpy kidney, the toxin producing bacteria belong to the *B. Welchii* group.

During the 1931 and 1932 seasons it was hoped to be able to confirm and if possible to extend the scope of the earlier field investigations on " struck " and at the same time gather information regarding the protective effect of vaccination against the disease, but in 1931 and 1932 there were comparatively few cases of " struck " and it has not been possible to make any positive advance with field researches. In both years over 2,000 sheep were vaccinated and in each field with the vaccinated sheep an equal number were left as controls. In 1931 seventeen sheep were obtained for post-mortem examination and only two of these were cases of " struck." In 1932 forty-six sheep were autopsied but only six of these were cases of " struck." During the latter season and for a period of three months, daily visits were paid to the Romney Marsh and all sheep in experiment that died were examined. Out of 2,050 vaccinated sheep, twenty died and one was considered to be a case of " struck " and of an equal number of control animals twenty-six died and five of these were cases of " struck." The sheep which had not died from " struck " again showed no evidence of having been affected by a contagious disease ;

in the majority of cases putrefactive changes had commenced and these were sometimes advanced but when the examinations were made on animals immediately after death there was no bacterial infection of the body tissues and in no instance has there been any suspicion of plant poisoning. The mortality in both 1931 and 1932 was not excessive particularly as the great majority of the sheep were in-lamb ewes or ewes with lambs at foot, and it now appears that in some years the losses on the Romney Marsh from what the layman calls " struck " are little if at all higher than the losses in other districts where there is no suspicion of the presence of any contagious or infectious disease causing the mortality. On the other hand, there are years or seasons when the mortality on the Marsh is undoubtedly high. 1930 was such a year and these researches indicate that this excessively high mortality is due to the disease that has been described under the name " struck." The reasons for the yearly fluctuations in the incidence of the disease are not at all clear but it is very probable that the quantity of the grazing is implicated. The belief that shortness of grazing throughout the late winter and spring is conducive to a high mortality is very generally held, conversely with an abundance of " winter keep " disease is not expected to be common. This experience or belief is compatible with the nature of the disease, the disease being of alimentary origin produced through the ingestion of bacteria, it is to be expected that the closer the grazing the greater the chances of sheep ingesting soil or pasture contaminated by the bacteria and consequently the greater the danger of some of the animals contracting disease.

During 1931 and 1932 further investigations were made on the experimentally produced disease. A possible objection to the former claim to have produced the disease experimentally was the large volume of bacterial culture and the great numbers of bacteria which had to be fed by the stomach tube. It was therefore planned to test the effect of the repeated administration of small doses of *B. paludis* culture by the mouth at intervals of a few days, the intention being to keep up a constant infection for several weeks or until sheep contracted the disease. A number of sheep were each fed 50 c.c. of culture, great care being exercised in its administration, but the following day a number of these sheep were found dead and the post-mortem examinations showed that the animals had died from a gas gangrene infection of the lungs, brought about by the inhalation of small quantities of culture when the animals were dosed. This method of infection had, therefore, to be abandoned.

Bacteria were then collected by centrifuging broth cultures of *B. paludis* ; these were enclosed in small gelatine capsules and administered to sheep. It was found that a number of sheep could be infected by giving them comparatively small quantities of bacteria in this manner, the greater the quantity of bacteria the greater the percentage of sheep infected but the disease was produced by one capsule containing the bacteria collected from 20 c.c. of broth culture and in several instances the disease was produced by two administrations at forty-eight hour intervals each of one capsule containing a number of bacteria equivalent to those present in 20 c.c. of broth culture. Both sheep on pasture and stall-fed animals were infected by this means. It is probable that the successful production of disease by this small quantity of bacteria depended upon an occasional capsule passing directly to the abomasum and the release of a comparatively small but concentrated number of bacteria in that organ or in the small intestine. Gelatine capsules are generally supposed to pass direct to the rumen but if this were invariably the case it seems impossible to account for the successful production of disease in a number of instances because in all experiments where the culture was fed by stomach tube the rumen had to be filled with relatively enormous quantities of culture, approximately 3 litres, before disease was produced.

If the entrance of the bacteria into the rumen interfered with setting up disease it was thought that the disease might be produced with greater facility in young lambs because these animals have but a rudimentary non-functioning rumen and food passes directly to the abomasum. Lambs a few days old were, therefore, fed regularly with cultures of bacteria administered in milk but the animals remained well. Furthermore, as there was the possibility that the chemical composition of the diet, varying either in the direction of an excess of protein or an excess of carbohydrate might furnish the bacteria with a more suitable pabulum for growth and toxin production, an experiment was designed in the hope that it might indicate the effects such a diet would have. A lamb was fed for some days on a diet of equal parts cow's milk and a 17 per cent solution of lactose while another lamb received equal parts of cow's milk and of a 17 per cent solution of casein. While on these diets the lambs received cultures of *B. paludis* but they remained well, finally diets of pure lactose solution and of pure casein solution were fed for several days, during part of which time *B. paludis* culture was administered, but the lambs remained well. Failure to produce disease in these lambs was interesting and will be referred to later but meantime it may be noted that the failure was in keeping with the epizootiological evidence, no disease of lambs on the Romney Marsh comparable to " struck " being recognized.

It is considered that " struck " is due to a bacterial toxin produced in the alimentary canal, but in previous experiments where toxin was fed to sheep disease had not been produced. The failures were attributed to the possibility of destruction of toxin having occurred in the rumen before the toxin could pass in sufficient quantity or concentration into the abomasum and small intestine to cause injury. Any part played by the rumen could be excluded by feeding lambs, accordingly considerable quantities of toxin, filtrates of broth culture of *B. paludis*, were fed to lambs, some of which had previously been prepared by administering ox bile by stomach tube, but in no instance was disease produced.

Immunization Experiments.

Guinea-pigs and rabbits were used in the preliminary immunization experiments, but the former animals proved less suitable than the latter and work was carried out principally with rabbits. Finally the methods of immunization were tested on sheep.

The following immunization agents were prepared and tested.

(1) Anatoxin. This consisted of the sterile broth filtrates of eighteen hour cultures of *B. paludis*. The filtrates were of standard toxicity, the toxicity being tested by the intravenous inoculation of mice or rabbits. Toxin of standard strength had 0·5 per cent formalin added to it and was then incubated at 37° C. for ten days. Thereafter and before use, the original toxin present in the filtrate had to be shown to be inert, relatively large doses being harmless for mice or rabbits on intravenous inoculation.

(2) Anaculture. This consisted of eighteen hours' broth cultures of *B. paludis* containing toxin of standard strength. The cultures were treated with formalin and were shown to be sterile and atoxic before use.

(3) Concentrated anatoxin. This was prepared from the dried precipitate collected from sterile filtrates of broth cultures of *B. paludis* precipitated with ammonia sulphate, 600 grams of ammonium sulphate being added to each litre of filtrate. A quantity of the dried precipitate was dissolved in distilled water, filtered through a Barhefeldt candle and the final concentration of toxin adjusted by the addition of the requisite amount of

sterile distilled water so as to give a solution of toxin ten times as strong as that present in the filtrates used in the preparation of anatoxin. The concentrated standardized toxin was treated with formalin and when atoxic it was ready for use.

(4) Filtered anaculture. This consisted of anaculture freed from bacteria by filtration through a bacteriological filter.

In all experiments upon rabbits and sheep the animals were bled before they were inoculated and their sera were tested for the presence of antitoxin by mixing measured quantities of serum with measured quantities of a standard solution of dried *B. paludis* toxin. These mixtures were allowed to stand at room temperature for one hour and were inoculated intravenously into mice. The amount of toxin used caused death within a given time, in no instance was the action of the toxin affected by the sera of non-inoculated sheep or rabbits and it was concluded that no antitoxin was present in their sera.

When a suitable time had elapsed after inoculation or vaccination to allow for the presence of immune bodies in the serum, the inoculated rabbits and sheep were bled and their sera again tested for antitoxin by the methods indicated above. In many cases the rabbits and sheep were vaccinated on two occasions and occasionally a third inoculation was given. After every inoculation the antitoxin content of their sera was tested. Finally the immunity of the rabbits was tested by inoculating the animals intravenously with multiples of a lethal dose of *B. paludis* toxin and the immunity of the vaccinated sheep was tested by feeding them with quantities of 3 litres or more of a *B. paludis* culture or inoculating them intramuscularly with small quantities of culture. Control, non-vaccinated sheep, were treated in the same manner.

The most encouraging results were obtained with anatoxin and anaculture, concentrated toxin and filtered anaculture appeared to be distinctly less valuable and after a few preliminary experiments they were discarded. The concentrated toxin was tested in the hope that it might be possible to immunize sheep by inoculating them with comparatively small quantities of material and filtered anaculture was tested because this offered an easier way of obtaining a bacteria free vaccine than that which had to be followed in the preparation of anatoxin. Comparisons made between anatoxin and anaculture showed no appreciable superiority of the one over the other. In both cases the original concentration of toxin had been the same before treatment with formalin. Therefore, both anatoxin and anaculture contained modified toxin but anaculture, besides consisting of modified toxin, contained the sterilized bacteria as well. As anatoxin alone produced as satisfactory an immunity as the combined anatoxin and sterilized bacteria, it appeared that resistance to infection depended mainly on an antitoxic and not an antibacterial immunity, and this was in accordance with expectations regarding a disease primarily toxaemic in character.

Both sheep and rabbits showed very considerable individual variation in their response to immunization but generally speaking the response was better when a large dose of anatoxin or anaculture was given and a second inoculation was generally beneficial. Some sheep, however, despite repeated inoculations with large doses failed to show any appreciable immunity ; antitoxin was not demonstrable in their sera and the animals succumbed to test feeding with *B. paludis* culture or to inoculation with culture. The majority of animals, however, showed a marked immunity response, antitoxin being detectable in their sera in very definite amounts. These animals resisted the oral administration of 3 or 3½ litres of culture which were fatal for control sheep, and vaccinated sheep with a high concentration of antitoxin in their sera were resistant to the intramuscular inoculation of small quantities of culture.

The tests to demonstrate resistance to infection, namely, feeding sheep with large quantities of culture and inoculating the animals intramuscularly with culture were extremely severe, but severe methods which could be relied on to produce disease in every instance had to be adopted where only a limited number of sheep were in experiment. It is therefore possible that those vaccinated sheep which were not immune to the drastic test methods employed, may have been sufficiently protected to withstand the risks of the ordinary field infection.

The results obtained with anatoxin being as favourable as those given by any other type of vaccine, it was decided that anatoxin was the most suitable type of vaccine for use in the field because there could be no question of its sterility, and accordingly it was impossible for the vaccine itself to set up disease. Therefore anatoxin was used for field vaccinations in both the 1931 and 1932 seasons. The vaccine was prepared and standardized in this laboratory. As previously noted, no definite results were obtained from its use on account of the comparative rareness of the disease.

At the present moment the value of field vaccinations against " struck " is not settled and the most that can be said is that carefully conducted experiments indicate that vaccination will very greatly reduce the mortality from the disease and therefore vaccination should be economically valuable in seasons when the disease is severe.

" Gangrene " or Gas Gangrene in Sheep.

This disease is not uncommon on the Romney Marsh where it is called " ganger " or " gangrene." The disease follows upon a history of trauma, occurring in ewes a short time after lambing and in lambs after castration or docking and occasionally in other sheep after shearing. The disease is caused through bacteria gaining entrance to the body through wounds in the genital tract or through wounds of the skin and underlying tissues intentionally or accidentally made. Similar disease is recognized in other countries and bacteria of the anaerobic group are the incriminated causal micro-organisms, *B. chauvoei* being regarded as the most frequent cause of the disease.

Before 1930 detailed bacteriological investigations had been made on material, muscle tissue, received from sheep that had died on the Romney Marsh and were considered to be either cases of " struck " or " gangrene." From the material from these cases, pathogenic bacteria were isolated in the following number of instances : *B. chauvoei* from seventeen cases, *Vibrion septique* from twenty-three cases and *B. paludis* from twelve cases. In a number of cases no pathogenic bacteria were present in the material. At that time it was considered probable that " struck " and " gangrene " were expressions of one and the same disease and that the disease was essentially an infection of the muscles, intramuscular and subcutaneous tissues with anaerobic bacteria. Cave (1905) in his report on " struck " concluded that the disease was the same as black quarter and caused by the black quarter bacillus. Black quarter is a gas gangrene infection of the muscles and their surrounding tissues generally caused by infection with *B. chauvoei*. Therefore from a study of the reports on the disease of sheep on the Romney Marsh and from my original bacteriological examinations the tentative conclusion that " struck " and " gangrene " were both examples of gas gangrene appeared justifiable, but during investigations made on the Romney Marsh in 1930 it quickly became evident that " struck " and " gangrene " were two entirely different diseases. During life or soon after death no suspicion of gas gangrene lesions was found in sheep alleged to be " struck," but the post-mortem multiplication of *B. paludis* caused a post-mortem change in the muscular and subcutaneous tissues simulating black quarter lesions or gas gangrene

lesions in gross appearance. " Struck " was therefore in no way analogous to black quarter or gas gangrene, but " ganger " or " gangrene " was found to be a similar disease to black quarter and it was proved that the great majority of cases were caused by *B. chauvoei*, the accepted causal micro-organism of black quarter. It is interesting to find that Cave never mentioned " ganger " or " gangrene " in any of his writings on disease of sheep on the Romney Marsh and it is possible that he may have regarded " struck " and " gangrene " as one and the same disease. There is, however, little doubt regarding the differentiation of these two diseases in the minds of Romney Marsh shepherds who diagnose " gangrene " with accuracy in the great majority of cases.

With the parturient ewe the symptoms are usually seen on the second or third day after lambing. There is the usual evidence of general systemic disturbance and frequently the vulva and surrounding tissues are tumefied and dark in colour and drops of serous, blood-tinged fluid exude through the neighbouring skin. In other instances these distinct external manifestations are absent. The animals at this stage lie persistently, breathing becomes laboured and, as the shepherd says, " They begin to heave." When this stage is reached it is known that in a few hours the sheep will be dead.

The disease is more prevalent during the latter half of the lambing season, and once a case has occurred in a flock more are feared. Sheep receiving manipulative assistance at lambing are the more prone to contract gas gangrene, and there is circumstantial evidence that the shepherd, while assisting the ewe at lambing, may transmit infection from animal to animal, and that the dangers of transmission are not overcome by the washing and disinfection of the shepherd's hands between cases.

At post-mortem examination the walls of the uterus are sometimes oedematous and greatly thickened ; the tissues round the vagina may be infiltrated with gelatinous fluid material, reddish in colour. Black quarter lesions are often found in groups of muscles, particularly those of the thigh or lumbar regions. When the carcase is fresh the great serous cavities and the organs therein show no particular abnormalities, but when the carcase has been lying for several hours, decomposition changes due to gas-forming bacteria are very evident. The disease is variable in incidence, the average mortality is low, but a 10 per cent mortality in a flock of 300 ewes has been observed.

Lambs usually die on the third or fourth day after being operated on. There may be little external evidence of gas gangrene infection though large areas of musculature may be involved, but these often show comparatively slight macroscopic changes, though in other instances distinct muscle lesions are observed. Losses are variable but occasionally they may be high. It appears that when lambs are castrated and docked, the more efficient the technique of the operator and the more thorough the precautions taken to prevent soil contamination of wounds, e.g. by placing lambs immediately after each individual is operated on upon clean pasture, instead of returning the lamb to the pound even though this be a temporary one and free from mud, the less the danger of their contracting " gangrene."

Personal experience of cases occurring after shearing is not sufficient to justify generalizations, but the disease appears to be comparable to that seen in the parturient ewe and the lamb.

Since 1932 fifty-two cases of gas gangrene have been studied in detail and the pathogenic bacteria from these cases isolated and their identity definitely established by cultural, biochemical, pathological and immunological tests. As a result it has been shown, Roberts and McEwen (1931), McEwen and Roberts (1932), that *B. chauvoei* is

the common causal micro-organism and that very exceptionally the disease may be caused by other species of micro-organisms. *B. paludis* has not been recovered from any of these cases. *V. septique*, however, was isolated on one or two occasions, sometimes associated with *B. chauvoei*, but *V. septique* was never recovered when the animal was examined within a few hours of death and in all probability *V. septique* is merely a secondary invader or a post-mortem invader and not the cause of disease. This conclusion is strengthened by the fact that from a few cases of " struck " examined some hours after death, *V. septique* has been recovered when there was overwhelming evidence to show that it was not the cause of disease.

These findings prior and since 1930 are in keeping with the investigations of other workers. Thus Miessner and Albrecht (1925) examined fifty-six specimens of muscle sent to the Veterinary High School at Hanover. From 54·28 per cent *B. chauvoei* were isolated, 18·7 per cent showed *V. septique*, and 18·7 per cent *B. chauvoei* and *V. septique*, 8·42 per cent gave *B. Welchii* or *B. Welchii* with *B. chauvoei* or *V. septique*. In eight instances no bacteria were isolated. Raebiger and Speigl (1924) report that 48 to 94 per cent of cases are due to *B. chauvoei* and 6 to 52 per cent to *V. septique*. Manninger (1924) in a flock where deaths followed castration, isolated *B. chauvoei* from the cases he examined ; on the same farm eleven sheep died after shearing and *B. chauvoei* was isolated and regarded as the causal micro-organism, but in another flock where the disease followed parturition, *V. septique* was recovered. Knall (1924) reports the isolation of *B. chauvoei* from twenty-two cases, *B. chauvoei* and *V. septique* from two cases, and in one instance *V. septique*. Wolters (1927) studied forty-four cases, and in thirty he found a *B. chauvoei* infection, but in thirteen *V. septique* was recovered and in one *B. sporogenes*. The greater importance of *B. chauvoei* is further emphasized by the findings of Marsh (1919 and 1923), of Marsh, Welsh and Jungherr (1928) and of Newsom and Cross (1933). The first author reported two outbreaks of gas gangrene in sheep due to *B. chauvoei* ; Marsh, Welsh and Jungherr recorded sixteen outbreaks ; a bacteriological examination was made upon one sheep from each of thirteen of these outbreaks and *B. chauvoei* was isolated in ten instances ; and Newsom and Cross found *B. chauvoei* to be the cause of an outbreak of disease following shearing.

The importance of the investigation on the Romney Marsh is the emphasis placed on the part played by *B. chauvoei*, this micro-organism having been found to be the cause of the disease in over 90 per cent of the cases autopsied since 1930. As the disease is irregular in incidence, it is doubtful if owners would trouble to practise immunization against gas gangrene. However, with lambing ewes, the animal assisted by the shepherd is the more likely to contract infection and if it were possible to give these a passive immunity by the inoculation of serum, individual cases would be treated. Immunization experiments have therefore been concerned with the production of a *B. chauvoei* immune serum and its prophylactic use. *B. chauvoei* ovine strain immune serum was prepared and tested on laboratory animals and sheep. During the past two seasons shepherds on a number of farms have carried a syringe and serum and inoculated the ewes as they received manipulative assistance. As far as these inoculations can be assessed, they appear to have been of value. Laboratory experiments confirm the probable value of the procedure. The intramuscular inoculation of a lethal dose of culture of *B. chauvoei* followed immediately or a few hours later by 20 c.c. of serum inoculated subcutaneously has prevented the disease developing. Further, the inoculation disease may be allowed to develop until the inoculated limb is swollen and painful, and the sheep shows systemic symptoms ; such animals would be certain to die in a few hours, but if inoculated intravenously with large doses of serum they will recover, McEwen and Roberts (1932). In

the field, inoculation of affected lambs with serum is not likely to be attended with very good results because the disease is not recognized until advanced, when serum treatment as administered by the shepherd would be of very limited value. The serum used up to the present was prepared by hyperimmunizing a horse against *B. chauvoei*. This work as indeed all the experimental work on the larger animals was performed under difficulties because the accommodation was far from ideal and at considerable distance from the laboratory. Only a small supply of serum was available for the present season, insufficient to supply the demand. Should serum be required for future seasons it may be difficult to obtain, as lack of funds and accommodation preclude its production at Wye.

Two *B. chauvoei* sera of continental origin were procured and tested, but were not found capable of effectively neutralizing the invasive or pathogenic properties of ovine strains of *B. chauvoei*, therefore they could not be recommended for use on the Romney Marsh, and as far as is known no other *B. chauvoei* serum is obtainable commercially.

Observations Maintained on the Romney Marsh for the Presence of Other Diseases Caused by Anaerobic Bacteria.

The work of Nielsen (1897), Jensen (1896, 1915), Gaiger (1922) and Dungal (1932) has shown that in Northern Europe, but more particularly in Iceland and Scotland, there is a fatal disease of sheep called Bradsot or Braxy and characterized by acute illness of short duration, the first intimation of disaster generally being the finding of affected sheep dead in the morning. In this disease the initial lesions are found in the walls of the abomasum and consist of haemorrhagic or inflamed areas. Microscopical examination of these areas shows masses of bacteria invading the tissues and bacteriological investigations have shown these bacteria to be *V. septique*. The disease is commonest during the late autumn and cases are generally found after a night frost. Death is attributed to a toxaemia, the toxin being produced by the bacteria which are found not only in the initial stomach lesions but distributed throughout the body at the time of death. *V. septique* is a ubiquitous micro-organism, but braxy has a very definite geographical distribution. Nevertheless, prior to 1930 this micro-organism had been isolated oftener than any other from material received from sheep on the Romney Marsh, attention was therefore paid to the possibility of braxy occurring there, but the characteristic lesions in the abomasum have never been encountered and the recent work conducted on the Romney Marsh indicates that *V. septique* though not infrequently found when the carcase is examined some hours after death is not the cause of sheep disease in that area.

Another disease similar to " struck " because of its sudden fatal character and caused by an anaerobic bacterium, is black disease of sheep in Australia and New Zealand and possibly a similar disease in Germany now referred to as the German bradsot to distinguish it from the Icelandic or Northern bradsot. This disease was shown by Dodd (1918, 1921) to be due to an anaerobic bacterium multiplying and producing its toxin in foci in the liver, causing necrosis of the liver cells and giving rise to yellow necrotic areas surrounded by a reddened haemorrhagic zone. The disease in Australia and New Zealand is invariably associated with an infestation of the liver with immature liver fluke. Dodd was the first to point out this association and it has been confirmed by others, Albiston (1927), Hopkirk (1927), Turner (1930), and it has now been shown that the spores of the causal micro-organism, a variant of *B. oedematiens*, may reach the body tissues from the intestine and there lie latent, Edgar (1928), Turner (1930). Predilection sites for the bacterial spores are the liver, spleen and bone marrow, and it is

considered that when immature fluke invade the liver tissue and injure the cells by boring their way towards the bile ducts, the injury permits the germination of bacterial spores should these be present and thus black disease is brought about, Turner (1930). The lesions and bacteriology of German bradsot are similar to those of black disease but in Germany it has not been so constantly associated with liver fluke infestation, Miessner, Meyn and Schoop (1931). However, the German observations are not so extensive as those of the Australian workers.

In no instance has a disease of this nature been seen on the Romney Marsh and very few sheep examined have been found infested with liver fluke. It is interesting to note that on one occasion from material from a Romney Marsh sheep sent to the laboratory, a micro-organism was isolated that was indistinguishable in all its characters from the causal organism of black disease and of the German bradsot, McEwen (1932), and on one occasion a typical strain of *B. oedematiens* was found to be the cause of " gangrene " in a ewe. Apart from these two occasions micro-organisms of the *B. oedematiens* group have not been found and it does not appear that they are the cause of more than an occasional sporadic case of disease.

Lamb dysentery and pulpy kidney disease of lambs have already been referred to and it has been pointed out that both these diseases are caused by bacteria of the *B. Welchii* group and that the causal micro-organisms produce toxins which are practically the same as *B. paludis* toxin. Therefore as *B. paludis* is a common cause of disease on the Romney Marsh it would not be surprising were lamb dysentery and pulpy kidney disease found there also. However, enquiries have not elicited any information that suggests that either of these diseases are present nor have post-mortem examinations of lambs on the Romney Marsh shown the presence of either disease and as already reported lambs fed with cultures of *B. paludis* have remained well.

SUMMARY.

There are two acute and fatal diseases of sheep on the Romney Marsh caused by anaerobic bacteria ; the one, "struck," is due to an alimentary infection with *B. paludis*, a micro-organism of the *B. Welchii* type. The other, " gangrene " or " ganger," results from a wound infection, generally with *B. chauvoei*.

These diseases do not account for all the cases of sudden death on the Romney Marsh but no other infectious or contagious disease has been found as the cause of acute illness and death. *V. septique*, the causal micro-organism of braxy, has been isolated from the tissues of sheep when the examination was made some hours after death. *V. septique*, however, has not been incriminated as the cause of disease on the Romney Marsh, and no case of braxy has been found. The causal micro-organism of black disease or the German bradsot has been recovered once in the many bacteriological examinations made on material from sheep on the Romney Marsh, but no case has been found resembling black disease or German bradsot.

The causal micro-organisms of " struck," lamb dysentery and pulpy kidney disease are similar but lamb dysentery and pulpy kidney disease have not been encountered on the Romney Marsh and if cases occur these are considered to be few in number.

" Struck " and infectious entero-toxaemia, a disease recently described from Australia, are similar types of disease.

Methods of active immunization against " struck " and of passive immunization against " gangrene " have been investigated.

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⁂ Since this article went to press my attention has been drawn to a comparatively small outbreak of disease, resembling lamb dysentery, in lambs on the Romney Marsh. One lamb was received for post-mortem examination and the intestinal lesions were similar to those commonly found in lamb dysentery.

SOIL PROFILE STUDIES OF PEAT PASTURES AT NACCOLT, NEAR WYE, KENT

By J. K. DUBEY, Ph.D. (London), M.S. (Illinois), F.I.C.S.

Department of Zoology and Geology, South-Eastern Agricultural College.

General and Geological.—Between the river Stour on the West and Alder Bank Wood, near Brook, on the East lies a small depressed area about a mile and a half long and roughly half a mile wide. The surface of this area is composed almost entirely of

[*Photo F Edenden*

Fig. 1.—A photograph taken in May to show the type of land investigated. Near the centre, but to the right, water can be seen on the surface, where the rushes have been pushed aside.

peat which obscures the alluvium and the Gault (which is, of course, clay) on the outcrop of which it lies.

A small tributary of the river Stour traverses the length of the area from South-east to North-west, and is responsible for the low-lying character of the topography. This stream draws its water from the Folkestone Beds which give rise to low hills at the southern boundary of the peat-invested area.

The valley formed by the river was probably flooded by subsidence of the land in Neolithic times and was consequently silted up with sandy materials from adjacent Folkestone Beds. Furthermore, the river Stour also silted up the outlet, which drained the water from this area into it. As a result of the valley thus being converted into a swamp, plant debris has given rise to the peat.

The presence of forest trees along one edge of the area, the draining of water into the depression from the surrounding higher ground, the waterlogging of the land and the consequent development of anaerobic conditions in the soil have all, no doubt, played their part in producing this peat.

[Photo F. Edenden

Fig. 2.—A pit showing various horizons of the soil profile in a dry section. Concretions of iron compounds are clearly visible as granular projections from the exposed soil section. The pit is 42 inches deep.

In some places the peat is found right on the surface, in varying stages of decomposition, while in others it is overlain by mineral soil. In a few fields the water-table is at the surface and the black spongy peat renders the land impassable (Fig. 1). On the slopes to the North and the South no trace of peat is found, though the soil even in these

adjoining places is by no means well drained, as evidenced by large quantities of concretions of iron compounds found quite near the surface.

Soil Profile of the Peat Soils.—All the soils of the area under investigation are strongly acid and the topography is depressed, though certain parts are sloping and fairly dry.

Seven examples of typical soil profiles of the peat soil for which the name Naccolt Series has been adopted are given below.

NACCOLT SERIES.

Dry Area.

1. Mr. Redsell's 15-acre field.
    - 0-8 in. Dark brown silt loam. It is iron-mottled and contains much undecomposed organic matter.
    - 8-18 in. Very dark brown silty clay loam. It contains brown concretions and very much undecomposed organic matter.
    - 18-50 in. Black peat.
    - Water-table in May, 30 in.

2. Six-acre Field (Fig. 2).
    - 0-8 in. Brown silt loam.
    - 8-32 in. Brown mottled silty clay loam to clay loam.
    - 32-38 in. Black peat.
    - 38-50 in. Bluish-grey sandy loam. Iron-mottled.
    - Water-table in May, 40 in.

Moderately Dry Area.

3. Mr. Hobbs's 4-acre field (Fig. 3).
    - 0-5 in. Dark brown fibrous silty loam, containing brown concretions.
    - 5-18 in. Black peat with concretions.
    - 18-30 in. Black peat but no concretions.
    - 30-38 in. Bluish-grey silty clay loam. Very much mottled.
    - 38-42 in. Bluish-grey silty loam.
    - 42-50 in. Bluish-grey sandy loam.
    - Water-table in May, 24 in.

Moderately Wet Area.

4. Mr. Redsell's 10-acre field.
    - 0-10 in. Dark brown silt loam with abundant iron concretions and undecomposed organic matter.
    - 10-40 in. Black peat.
    - 40-50 in. Bluish-grey sandy clay loam.
    - Water-table in May, 20 in.

5. Mr. Redsell's 12-acre field.
    - 0-16 in. Black peat.
    - 16-34 in. Bluish-grey silty clay loam with an abundance of brown concretions and undecomposed organic matter.
    - 34-42 in. Bluish-grey silt loam which ends in silty loam.
    - 42-50 in. Bluish-grey loamy sand.
    - Water-table in May, 22 in.

WET AREA.

6. Mr. Hobbs's 10-acre field.
   0-4 in. Dark silt loam with abundant organic matter and brown concretions.
   4-8 in. Dark brown to black spongy peat with some mineral soil and brown concretions
   8 in. onward. Black peat.
   Water-table in May, 8-10 in.

[Photo F. Edenden

FIG 3 —A pit showing dark brown peat with some admixture of mineral matter and brown concretions There is spongy black peat below This in turn is followed by sandy material, which is not visible owing to the high water table, as shown in the pit (24 inches from the surface) Photograph taken in May.

MARSHY AREA.

7. Mr. Hobbs's 19-acre field.
   0 in. onward. Black peat.
   Water-table in May—at the surface.

PEATLESS LAND.

No peat is found behind the wood or in fields adjoining the slope or those adjacent to the Stour bank. One example of each is given below.

8. Field behind Alder Bank Wood.
   0-12 in. Bright brown silt loam, brown concretions present.
   12-18 in. Brown silty clay loam, brown concretions present.

18-24 in. Grey bleached silty loam, slightly mottled.
24-32 in. Bluish-grey silt loam.
32-52 in. Bluish-grey fine sandy loam.
Water-table in May—not reached.

9. Northern Slope. Mr. Long's 35-acre field.
0-8 in. Brown loam.
8-12 in. Brown silty loam.
12-24 in. Reddish-brown silt loam. Shows mottling and deposition of iron compounds.
24-50 in. Greyish-brown very fine sandy loam to fine sandy loam.
Water-table in May—not reached.

10. Field adjacent to the Stour bank.
0-8 in. Brown silt loam, contains large quantity of brown concretions.
8-18 in. Yellowish-brown silt loam with brown mottling and concretions.
18-50 in. Yellowish sandy loam to loamy sand.
Water-table in May, 40 in.

Profiles 8 to 10 are given here to provide local comparison with the peat soil of the Naccolt series, but no useful purpose can at the moment be served by giving them names.

Correlation between Plants and Soil Profile.

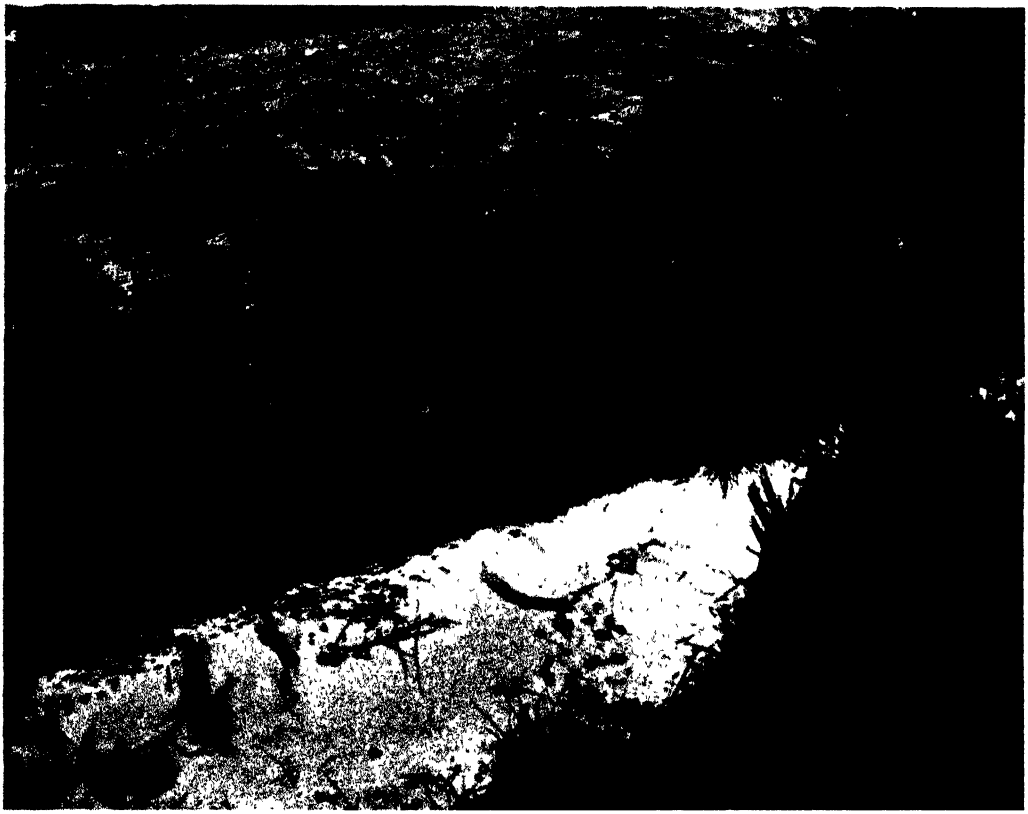
Unfortunately there has been very little opportunity for studying the flora. One inspection was made in May and another in June by Mr. S. T. Parkinson, Head of the Department of Botany, who was accompanied by Mr. R. M. Harrison on each occasion. I am grateful to them for coming to Naccolt with me to identify a series of plants. These inspections showed that the type of plant present corresponds with that found on acid soils passing into marshland, with an occasional bogland association.

The area on the 10-acre field most nearly corresponded with that of poor class normal pasture. The herbage was largely composed of dense tufts consisting of rushes mixed with Yorkshire fog (*Holcus lanatus* L.); smooth-stalked meadow grass (*Poa pratensis* L.); and a few plants of sorrel (*Rumex acetosa* L.) and occasionally dock (*Rumex obtusifolius* L.). Outside the clumps the predominant grasses were Yorkshire fog (*Holcus lanatus* L.); smooth-stalked meadow grass (*Poa pratensis* L.); perennial rye grass (*Lolium perenne* L.); meadow foxtail (*Alopecurus pratensis* L.); bent (*Agrostis* sp.) and sheep's fescue (*Festuca ovina* var.), with a small quantity of wild white clover (*Trifolium repens* L.). Buttercup (*Ranunculus repens* L. and *R. acris* L.); moss spp.; sorrel (*Rumex acetosa* L.); horsetail (*Equisetum* sp.); Germander Speedwell (*Veronica chamoedrys* L.), and Silverweed (*Potentilla anserina* L.) also occurred locally. Other plants appearing in the wetter portions of the area were ladies' smock (*Cardamine pratensis* L.); marsh bird's foot trefoil (*Lotus major* Scop.); marsh thistle (*Carduus palustris* L.); chickweed (*Stellaria* sp.); sedges (*Carex* sp.); occasional plants of water plantain (*Alisma plantago* L.) and of the green winged orchid (*Orchis morio* L.), also creeping scirpus (*Scirpus palustris* L.).

The ditch (Fig. 4) separating the field from a road was overshadowed with black alder (*Alnus glutinsa* L.) and willows (*Salix* sp.), and a few brambles (*Rubus fruticosus* L.) were present. The dominant grasses are floating poa (*Poa fluitans* Scop.), rough-stalked meadow grass (*Poa trivialis* L.) and water poa (*Poa aquatica* L.), figwort (*Scrophularia*

aquatica L.), willow herb (*Epilobrium* sp.), ragged robin (*Lychnis Flos-cuculi* L.), Brooklime (*Veronica beccabunga* L.), and other water loving plants such as *Solanum dulcamara* L., *Cardamine amara* L. and *Nasturtium officinale* Br. were also present.

The flora in the 19-acre field varies greatly, passing into that of true bogland towards the North. In addition to the plants already mentioned, meadow sweet (*Spirea ulmaria* L.) and brown bent (*Agrostis canina* L.) occur. Typical marsh and bog plants such as bog moss (*Sphagnum* sp.), marsh pennywort (*Hydrocotyle vulgaris* L.),



[*Photo F. Edenden*

Fig. 4.—A drainage ditch with a section composed entirely of peat. An elder tree and brambles are shown in the foreground, while water is visible in the drainage ditch itself. Owing to strong sunlight the shadow of the branches has produced a light and shade effect on the 3-foot bank of the ditch, which really consists of black peat.

tormentil (*Potentille tormentilla* Neck.), mint (*Mentha* sp.) and water bedstraw (*Galium uliginosum* L.) are abundant. Water poa (*Poa aquatica* L.) was plentiful near the ditches. In the marshy areas the vegetation forms patches of considerable size dominated by single plants, such as rushes, water poa, horsetail, sweet vernal, hard fescue and sorrel. Sedges, marsh orchids and marsh thistle were fairly plentiful. Some plants of Bur-reed (*Sparganium ramosum* Huds.) were also found.

Although bog plants such as *Sphagnum* occur, it will be noted that marsh plants rather than bog plants predominate. This may be due to the fact that the water in the

ditches is in continuous, though very slow, motion. Wild white and red clover were present in all the fields.

Reclamation.

It seems to the writer that the natural depressed topography with a live rivulet running through it would make the complete draining of the area impossible, though the digging of additional drains and cleaning of the old ones will doubtless bring about much improvement in the land.

Acknowledgments.

The writer wishes to offer his sincere thanks to Principal R. M. Wilson for his continued interest in his soil studies, and to the Rev. Dr. S. Graham Brade-Birks and Messrs. B. S. Furneaux, S. T. Parkinson and R. M. Harrison for valuable advice and assistance.

Summary.

1. The geology of the area is briefly described.

2. Examples to illustrate the soil profiles of the peat soil and the surrounding area are given.

3. The *Naccolt series*, as previously shown, consists of peat over an alluvium of re-sorted local materials including Gault (clay) and Folkestone Beds (sand). The highly organic nature of the material gives a black to dark brown colour to the surface, the soil of the series occupies a depressed waterlogged area. Peat may occur at the surface, but in rare cases dry areas may have as much as 32 inches of dark brown soil overlying peat. The peat itself varies in thickness from 6 inches upwards and is typically followed by bluish-grey waterlogged re-sorted geological materials containing iron compounds.

The reaction is always strongly acid.

4. A correlation between plants and soil profile is established. It is shown that although bog plants such as *Sphagnum* occur, the marsh plants rather than bog plants predominate. This is probably due to the fact that the water in the ditches is in continuous, though in very slow, motion.

5. It is pointed out that owing to natural topography complete reclamation of the area seems impossible, but its fertility could be greatly improved by a better system of drainage.

MILKING TIMES

INTER-COUNTY VARIATIONS IN TIME AND INTERVAL.

By H. Barkworth,
Dairy Bacteriologist, South-Eastern Agricultural College, Wye, Kent.

Since 1928 the results of the keeping quality tests have been recorded in hours, from the time of milking to the end of the period of sweetness (1). Previously a very large number of samples had been tested, but because the system until then in force did not require it, the actual milking time was not recorded before 1928. For research purposes it was desired to combine the keeping quality results of all samples. The actual keeping quality test is the same (2) and the difference lies in reporting finally either hours from milking time or days of sweetness. It seems, therefore, that samples of the earlier series could be placed on a basis of comparison with later tests if the results previously recorded in days were re-calculated as hours applying to individual herds, the mean milking times of the herds tested in later years. The necessary tabulation of milking times was undertaken and the results are discussed below.

At the outset of any discussion on milking times it is necessary to give an exact definition of that term. Disregarding the varying time occupied by tying up the cows, grooming and so on, we have an assured basis in the time when actual milking starts. This may be called the Starting Time, and is the time recorded by the sender. An allowance must be made for the time taken to complete milking of the whole herd, and the Ministry of Agriculture (2) defines Milking Time as " half an hour after milking actually commences in the cowshed." In practice the official milking time is recorded only to the nearest half an hour, quarter-past reckoning as the half-hour and quarter-to being considered as the hour. Thus a starting time of 3.40 p.m. would give a milking time of 4.00 p.m., while a starting time of 3.45 p.m. would be classed as a milking time of 4.30 p.m.

In seeking to establish mean morning and afternoon milking times for the area of Kent, Surrey, West and East Sussex, the question arises how far calculated mean milking times for the whole area are applicable to any one county. Records of the actual milking times on different farms have been obtained during the numerous clean milk competitions which have taken place in these counties, as it has been a practice to record the starting time for each sample since 1928. In the three counties, Kent, Surrey and West Sussex, morning and afternoon samples are sent by both the farmer and the inspecting judge, the starting time being given in the case of each sample. In East Sussex the Inspecting Judge states the times at which morning and afternoon milking are supposed to start. Under the first system the milking times may vary by half an hour, occasionally more, but in a series of samples it is always possible to judge the mean time. With the system in vogue in East Sussex these individual variations are eliminated, as one time stands for all samples, but the records were carefully checked with the Inspecting Judge and may be accepted as giving a fair representation of the case. Duplicate entries have been eliminated and only when the milking times have shown incompatible variations has a herd been included more than once. The intervention of a mid-day milking, as with

DISTRIBUTION OF MILKING TIMES.

TABLE I.

KENT.

a.m.	p.m. 1.30	2	2.30	3	3.30	4	4.30	5	5.30	6	6.30	7	7.30	Total
4.30					1									1
5		1	1											2
5 30		1	2	5	2		1							11
6		1	1	4	4	2	1	1						14
6 30		2	1	1	7	6	4	1	1					23
7		1				9	3	1						14
7 30					1		1							2
8														
Total		6	5	10	15	17	10	3	1					67

TABLE II.

SURREY.

a m	p m 1.30	2	2.30	3	3.30	4	4.30	5	5.30	6	6.30	7	7.30	Total
4.30		1												1
5														
5.30			2		3									5
6	1		2	7	14	5	2	2						33
6.30			4	7	13	10	8	1						43
7				4	7	12	4	1		1				29
7.30					4	2	6							12
8						1	1							2
Total	1	1	8	18	41	30	21	4		1				125

TABLE III.

WEST SUSSEX.

a m.	p m 1.30	2	2.30	3	3.30	4	4.30	5	5.30	6	6.30	7	7.30	Total
4.30														
5		1	1	1										3
5.30			3	5	2									10
6			6	14	10		1		1					32
6.30	1		1	1	10	7	1			1				22
7			1		1	3								5
7.30							1	2						3
8														
Total	1	1	12	21	23	10	3	2	1	1				75

herds milking three times in twenty-four hours, would invalidate a milking interval calculated between the first and last milking, but according to enquiries made, the times given in the tables do not include any herds milking three times daily. The final results are seen in Tables I-IV where the paired morning and afternoon milking times are set out for each herd, as well as totals at each half-hour interval for each county. Table V shows the combined data for all four counties.

A glance at Tables I-IV will show that in all cases the variation in afternoon milking times is much greater than that of morning times. While afternoon times vary over a range of six hours (1.30 p.m.-7.30 p.m.) morning milkings are confined within a 3½ hour period (4.30 a.m.-8.0 a.m.). The most compact grouping occurs in Surrey, where there is also a freedom from very late or very early milking times such as occur in Kent and West Sussex, whilst East Sussex is notable for late milkings.

Mean milking times have been calculated from Tables I-V with the following results :—

Kent.—1928, 1929, 1931, totalling sixty-seven different herds, the calculated mean times are 6.17 a.m. and 3.35 p.m. If these times are adjusted to the nearest half-hour we get finally **6.30 a.m.** and **3.30 p.m.**

Surrey.—The five years 1928-32 give 125 herds and the calculated times are 6.31 a.m. and 3.41 p.m. which on adjustment become **6.30 a.m.** and **3.30 p.m.**

West Sussex.—1928-30 gives seventy-five herds with calculated times of 6.10 a.m. and 3.22 p.m. giving adjusted times of **6.00 a.m.** and **3.30 p.m.**

East Sussex.—1928-32, 167 herds give calculated mean milking times of 6.11 a.m. and 3.37 p.m. ; these times adjust to **6.00 a.m.** and **3.30 p.m.**

For all Counties combined, the calculated times are 6.18 a.m. and 3.35 p.m. and adjusting to the nearest half-hour we have **6.30 a.m.** and **3.30 p.m.**

There is a tendency to earlier morning milking in West and East Sussex and a tendency to later afternoon times in Kent, as shown by the totals for each county. The calculated means for each table come very close to the mean for the whole area and it is only when we reduce these means to the nearest half-hour that divergence becomes marked. The official mean times agree at 3.30 p.m. for all, but 6.30 a.m. for Kent and Surrey and 6.00 a.m. East and West Sussex.

In all the tables a diagonal line drawn from the top of the first column to the bottom of the eighth would show the nine-hour milking interval, above that line and to the right would mean a longer interval, below and to the left would mean a shorter interval. The herds have been grouped according to milking interval in Table VI, which shows that though extremes do occur, 9 or 9½ hours is the favoured interval. It will, moreover, be seen from Tables I-V that early afternoon milking times tend to be associated with short intervals and late afternoon times with long intervals. In the case of Table V, all counties, the afternoon times correlate well with the interval, $r = \cdot 67$, but if the morning times are compared with the interval the factor is only $\cdot 36$. The difference between the two factors is well beyond the significant value and shows statistically what is broadly apparent from the Tables, that extreme afternoon milking times connect with extreme intervals, and that as a whole the milking interval is more dependent on the afternoon time than on the morning time. The figures for Table V would obviously apply, with slight modification, to the individual Tables Nos. I-IV.

DISTRIBUTION OF MILKING TIMES.

Table IV. East Sussex.

a.m.	p.m. 1.30	2	2.30	3	3.30	4	4.30	5	5.30	6	6.30	7	7.30	Total
4.30														
5			1											1
5.30			3	21	18		1		1					44
6				14	29	6								49
6.30			1		29	12	5		1					48
7					5	8	2	2		1				18
7.30					1	1	3				1		1	7
8														
Total			5	35	82	27	11	2	2	1	1		1	167

Table V. All Counties.

a.m.	p.m. 1.30	2	2.30	3	3.30	4	4.30	5	5.30	6	6.30	7	7.30	Total
4.30		1			1									2
5		2	3	1										6
5.30		1	10	31	25		2		1					70
6	1	1	9	39	57	13	4	3	1					128
6.30	1	2	7	9	59	35	18	2	2	1				136
7		1	1	4	13	32	9	4		2				66
7.30					6	3	11	2			1		1	24
8						1	1							2
Total	2	8	30	84	161	84	45	11	4	3	1		1	434

Table VI.

Milking Interval.

	Hours. 7	7½	8	8½	9	9½	10	10½	11	11½	12	Mean. hrs.	Mean. mins.
Kent	1	2	3	3	24	19	9	2	4			9	18
Surrey		1	13	19	40	29	17	3	3			9	9
West Sussex . ..	1	1	1	8	32	25	4	1		2		9	12
East Sussex			2	6	57	65	31		4		2	9	26
Totals	2	4	19	36	153	138	61	6	11	2	2	9	17

Early afternoon times, with short intervals usually betoken a producer-retailer who retails his own milk twice daily, after each milking. It is significant that such herds are absent in Surrey where producer-retailers are many and the suggestion is that the afternoon milk is mainly carried over and issued by an early morning delivery, the morning milk being retailed in the mid-morning. There are obvious advantages to both producer-retailer and consumer in this method. The preponderance of late milking herds in East Sussex is probably due to the number of small herds in the area where the dairy staff are also the general farm staff and milking is done after the day's field work.

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(2) Guide to the Conduct of Clean Milk Competitions. 1932, *Min. Agric. Bull.*, No. 46.

COLIFORM ORGANISMS AND KEEPING QUALITY OF MILK

By H. BARKWORTH,
Dairy Bacteriologist, South-Eastern Agricultural College, Wye, Kent.

THE harmful effect of the presence of coliform organisms on the keeping quality of milk was first noted by the writer in 1927 (1) and he published further figures on the subject in 1929 (2). The results here presented make a further contribution to our knowledge on the subject and offer new and striking evidence of the deleterious action of coliform organisms on milk. The material, totalling approximately 4,900 samples of morning milk and 5,400 samples of afternoon milk, has been accumulated in our laboratory over the years 1923 to 1932, and consists mainly of samples tested for the recurring clean milk competitions in the counties of Kent, Surrey, East and West Sussex, most of the samples arriving in the period January to June of each year. These amassed results were tabulated not only according to total count, keeping quality, and presence of coliform organisms, but attention was also given to the degree of coliform contamination. The final results are presented graphically in Charts I and II.

For present purposes we may say that "Coliform Bacteria" means all bacteria reacting to the presumptive *B. coli* test in lactose-bile-salt-peptone broth, i.e. bacteria fermenting milk sugar despite the presence of bile salt. Total count was tested on standard agar, 48 hours at 37° C. (3).

Each chart shows six curves. The first curve deals with all samples in which coliform organisms were not found in 1 c.cm. of milk, and shows the average keeping quality of samples according to their total bacterial content. The second curve gives similar information in the case of samples in which coliform organisms occurred in 1 c.cm. of milk, but not in lesser fractions. The third curve gives data for samples showing presence of coliform organisms in 1/10th c.cm., and so on for the more highly contaminated samples, in which these organisms were found in 1/100th and 1/1,000th c.cm. Finally there is a curve showing the results of all samples combined.

It will be noticed at once that the average keeping qualities in the case of afternoon samples are several hours less than those of morning samples of the same total count (4), and there are also technical reasons for tabulating samples of morning and afternoon milk separately, so that Chart I gives results for morning samples and Chart II deals with afternoon milk. Apart from the difference in average keeping quality, the general trend of the curves is the same in both cases, and it seems that with regard to the action of coliform organisms there is little, if any, difference between morning and afternoon milk. It must also be noted that in practice samples containing coliform organisms in high dilution, 1/100th and 1/1,000th c.cm., seldom occur with a really low total count, and the irregularity at the commencement of these curves is due to the stations being founded on one or very few examples.

Chart I—Morning Milk.

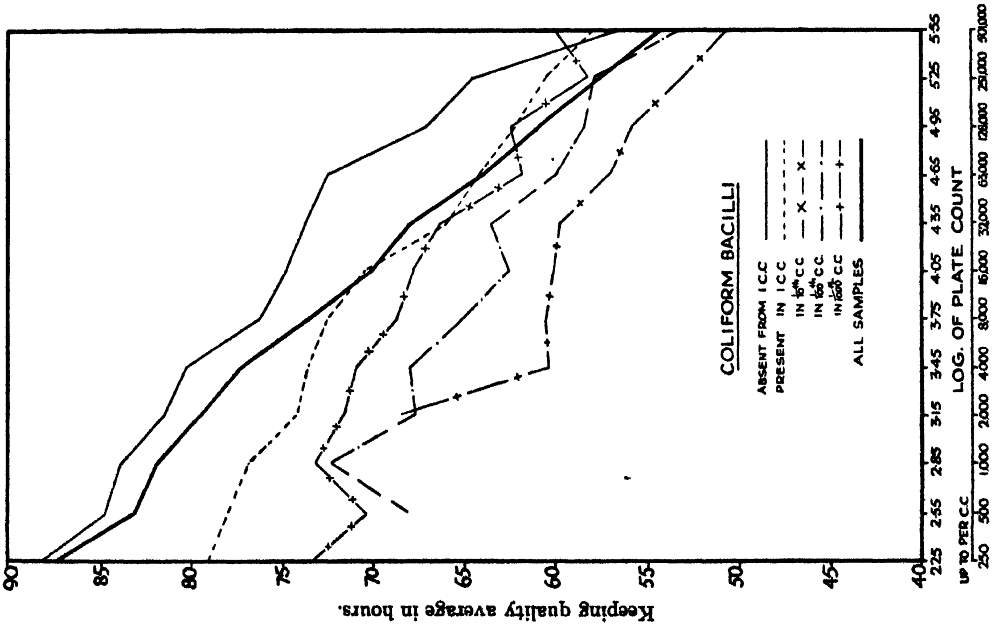
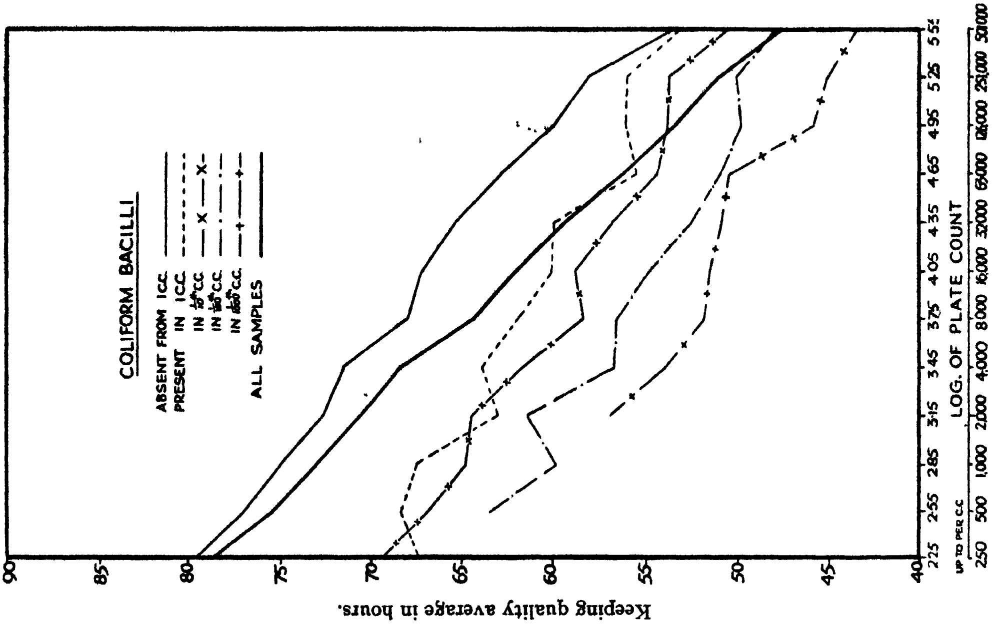


Chart II—Afternoon Milk.



The following lessons may be learnt from the charts :—

1. The presence of coliform bacteria shortens the average keeping quality.

2. The amount by which the average is lowered (the depression) is directly associated with the intensity of the contamination ; contamination in 1/10th c.cm. depresses more than contamination in 1 c.cm. and so on.

3. There is a more marked depression caused by initial contamination than at any subsequent stage. The difference is more marked between the curve for " absent " and the curve for " 1 c.cm." than between any other curves. This may be partly because some of the " absent " samples might be free in 10 c.cm. as well as in 1 c.cm.

4. Really low counts are important when we desire long keeping quality.

The first group only reaches 250 per c.cm. total bacterial count, yet the fall in average keeping quality between this and the next group, 500 per c.cm., is quite as marked as between any other two groups.

A statistical examination of the figures is being undertaken.

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(1) BARKWORTH, H., MATTICK, A. T. R., TAYLOR, M. G. D. and STENHOUSE WILLIAMS, R. 1927. " The Relationship between the Bacteriological Content and the Keeping Quality of Milk." *Jour. Min. Agric.*, 1927, Vol. XXXIII, No. 11.

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(3) ANON. 1928. " Guide to the Conduct of Clean Milk Competitions." *Min. Agric. Misc. Pub.* No. 43. 3rd edition.

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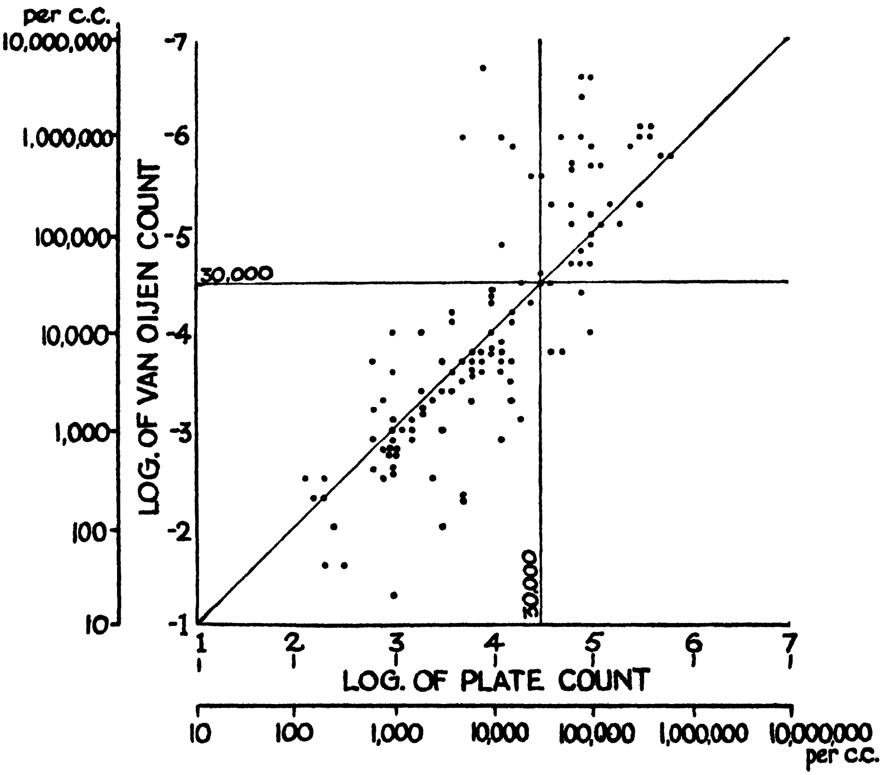
VAN OIJEN'S TEST: A RAPID METHOD FOR COUNTING HIGH CLASS MILK

By H. Barkworth,
Dairy Bacteriologist, South-Eastern Agricultural College.

This test is an improvement of the Frost Little Plate Method and was devised and perfected by Professor C. F. Van Oijen (1928) of the State University, Utrecht, Holland. The milk is spread in a thin film on a glass slide, mixed with nutrient jelly, and the

Series I (low-count milk).

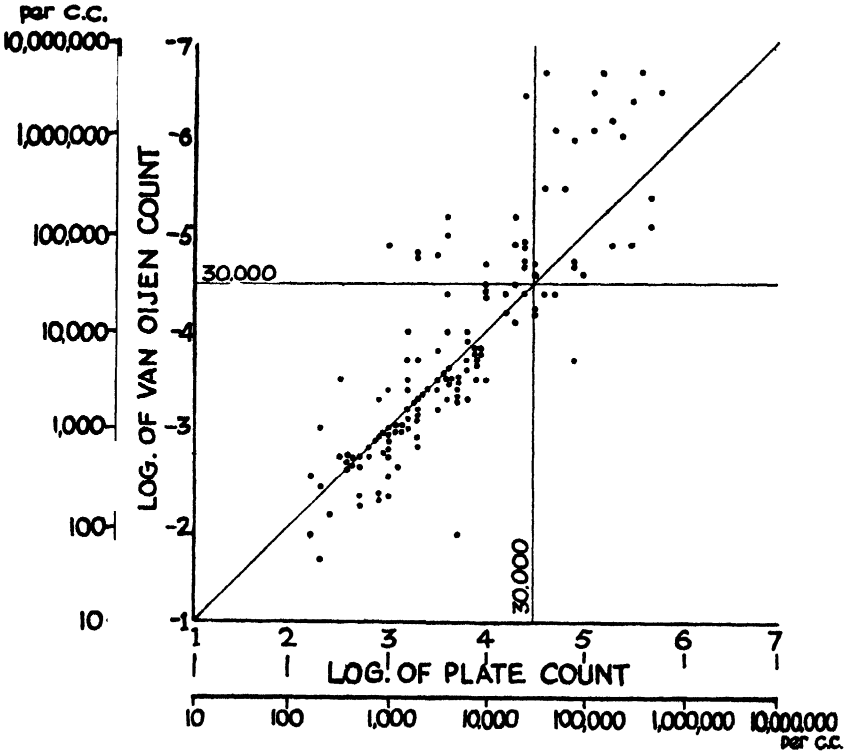


Excludes 2 samples plate count uncountable.

colonies counted after nine to sixteen hours' incubation. A special cover glass ruled in one millimetre squares is placed over the now dried and stained film and the colonies counted under low magnification. The amount of milk and the area over which it is spread are so regulated that each individual square on the cover glass represents 1/10,000th c.cm. of milk.

In practice 1/10th c.cm. of milk is equally divided over two rectangles each 20 by 25 mm. previously marked on a glass slide. As the cover glass is divided into squares of 1 mm. it follows that each rectangle has twenty rows of twenty-five squares each. The rule is to count the colonies in every other row. The total for each rectangle may then be multiplied by 40 to give the estimate of colonies per c.cm. of milk and finally the results for two rectangles are averaged. The final result is therefore the average of the examination of two 1/40ths of a c.cm. of milk. Although it is believed that counts can be made up to 200,000 per c.cm., Van Oijen does not use this test at the higher ranges. Counting is greatly facilitated by the use of a tally counter.

Series II (low-count milk, improved Van Oijen technique).



The test is rapid, cheap, requires a minimum of apparatus and in contradistinction to other rapid tests it does distinguish milks of really low count, and it seemed that such a test might be of use in England. The first step was to discover if the results obtained were reasonably similar to those given by the already established methods and so a series of duplicate tests was made, each sample being tested by the standardized technique of the Ministry of Agriculture (Anon., 1928) and also by Van Oijen's method. Although this test was intended by its originator only for clean milk it was thought advisable to see what would happen if high-count milks were tested. If a test will count up to 200,000 per c.cm. it might be that by a single dilution of 1 in 10 we could estimate up to 2,000,000 per c.cm.

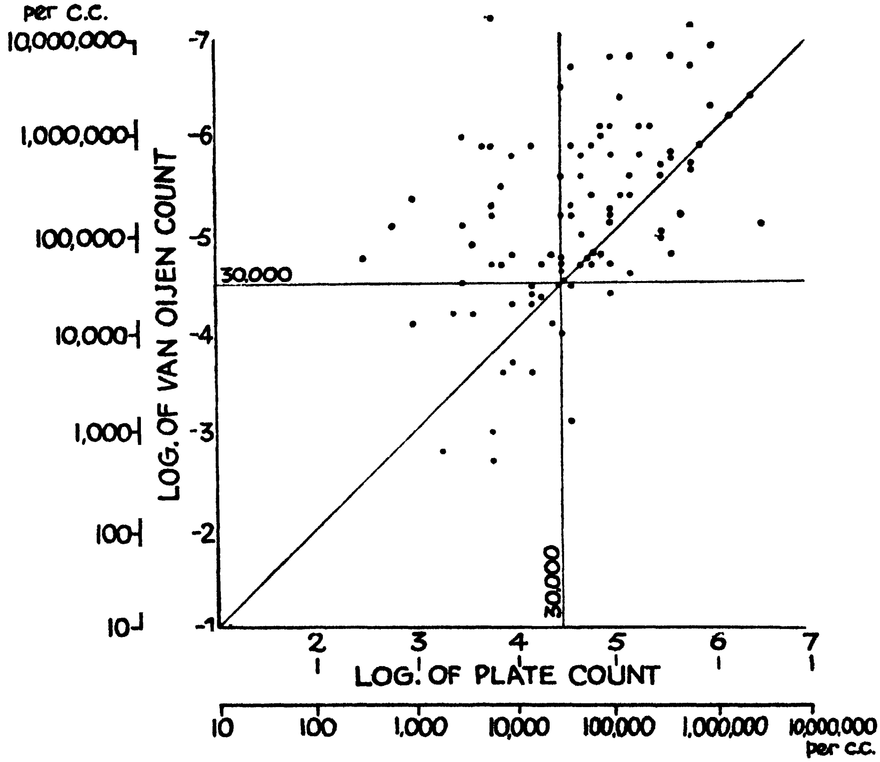
The results of the tests made are seen in the table and in Plates 1, 2 and 3. Series I and II are from low-count milks, except that in the case of Series I the 1/10th c.cm.

milk for the Van Oijen test was measured from the pipette at once, whereas in Series II the milk was raised and lowered in the pipette six times before the final measurement was taken. Series III is from high-count milk such as is commonly termed "market milk," where it is improbable that the utensils have been sterilized. Many of these Van Oijen counts were from a 1 in 10 dilution.

RESULTS.

According to Series I and II the Van Oijen Test gives good agreement at low counts, possibly as far as 30,000 per c.cm. The refinement of technique in Series II.

Series III (high-count milk).



Excludes 32 samples Van Oijen results uncountable.

appears worth while. At high counts, as seen in Series III, all agreement is lost. This divergence of results is in all probability largely connected with the amount of milk in the actual culture. Since this work was done the Ministry of Agriculture has adopted a 1 per cent milk agar and the use of such a medium may alter the results obtained by the plate count at the higher ranges. The results obtained in these preliminary trials encourage further consideration of the matter and a more detailed investigation is now in hand. It must be remembered that the Van Oijen Test is only a count test and does not tell us anything of the presence of coliform organisms. This omission, which is important (Barkworth, 1933), might be overcome, but it is also desirable to compare the results of replicate tests by both methods. The apparent tendency is for Van Oijen results to be slightly lower at low counts and for the plate count to be lower with high count samples.

ESTIMATED COLONIES PER C.CM. OF MILK.

SERIES I LOW-COUNT MILK.				SERIES II LOW-COUNT MILK.				SERIES III HIGH-COUNT MILK.			
Plate Count.	Van Oijen Test	Plate Count	Van Oijen Test	Plate Count	Van Oijen Test	Plate Count	Van Oijen Test	Plate Count	Van Oijen Test.	Plate Count	Van Oijen Test.
140	300	13,000	3,980	160	80	3,800	3,120	800	68,000	79,000	53,000
170	200	13,700	860	170	300	3,900	9,240	600	180,000	81,000	1,360,000
180	180	13,700	1,040,000	190	20	3,900	175,000	1,000	500,000	89,000	Uncountable.
190	320	14,200	12,160	200	1,020	3,900	3,250	1,100	12,240	90,000	6,000,000
210	40	15,200	3,200	220	280	4,000	1,890	1,800	580	90,000	160,000
240	100	15,600	2,200	250	140	4,300	28,000	2,600	16,000	94,000	1,300,000
340	40	16,100	17,400	340	2,820	4,500	2,120	3,000	113,500	95,000	Uncountable.
620-	5,000	16,700	750,000	350	460	4,700	80	3,000	950,000	100,000	630,000
630	380	17,000	5,400	380	380	4,900	1,880	3,400	29,000	100,000	146,500
640	1,460	21,400	1,400	400	480	5,000	3,440	4,100	15,000	106,000	25,000
650	720	21,600	30,000	400	360	5,400	2,800	4,400	80,000	110,000	164,500
820	600	23,600	22,000	420	460	5,500	3,220	4,700	750,000	114,000	50,000
850	300	24,200	420,000	420	460	5,800	4,660	6,000	775,000	116,000	2,500,000
880	1,985	32,000	360,000	480	200	6,000	2,000	6,200	909,000	133,000	Uncountable.
900	20	34,000	36,000	500	390	6,400	8,760	6,500	15,000,000	136,000	280,000
910	12,000	35,000	33,700	540	520	6,700	10,800	6,600	1,220	144,000	280,000
940	620	38,000	32,000	560	160	7,000	4,400	6,700	46,500	146,000	410,000
960	420	42,000	6,280	600	560	7,100	5,920	7,000	177,500	154,000	40,000
960	660	42,000	205,000	700	660	7,300	5,060	7,000	740	176,000	6,000,000
960	4,800	45,000	6,080	770	780	7,600	5,220	7,500	4,020	190,000	310,000
970	700	46,000	1,030,000	780	180	7,900	3,040	7,600	Uncountable.	213,000	1,360,000
1,000	680	60,000	540,000	800	800	8,200	6,040	7,700	350,000	235,000	1,315,000
1,040	980	62,000	480,000	800	720	8,300	6,600	8,000	Uncountable	300,000	360,000
1,070	1,160	65,000	125,000	830	1,860	8,500	7,020	8,600	Uncountable.	300,000	400,000
1,100	800	66,000	52,200	880	220	9,100	3,420	8,700	52,000	300,000	Uncountable.
1,220	300	67,000	235,000	950	880	11,600	32,500	8,800	Uncountable	310,000	Uncountable.
1,300	1,190	76,000	45,000	950	340	11,700	45,000	9,000	5,280	320,000	97,500
1,420	1,500	77,000	26,600	950	700	11,800	22,500	9,500	22,000	320,000	97,000
1,490	940	78,000	2,650,000	980	200	12,200	26,840	10,600	600,000	360,000	Uncountable
1,720	1,160	80,000	65,000	990	960	16,000	23,500	11,200	60,000	360,000	700,000
1,880	1,760	82,000	2,000,000	1,000	580	16,500	16,020	14,200	4,160	420,000	6,000,000
1,950	10,820	87,000	1,050,000	1,040	480	17,800	33,000	15,200	20,000	420,000	58,000
2,110	1,760	90,000	10,400	1,050	820	20,000	13,440	15,500	23,900	430,000	Uncountable.
2,210	2,240	91,000	75,000	1,050	2,760	20,700	172,000	15,800	Uncountable.	440,000	600,000
2,600	320	92,000	750,000	1,080	83,000	21,300	71,500	16,800	770,000	450,000	Uncountable
2,680	1,820	95,000	108,000	1,130	1,120	24,000	84,500	17,300	35,000	560,000	162,000
3,200	900	95,000	510,000	1,260	920	24,500	47,500	19,100	37,000	580,000	5,000,000
3,300	100	100,000	150,000	1,320	1,000	25,000	6,150,000	21,500	22,500	600,000	Uncountable.
3,300	2,660	103,000	3,680,000	1,350	1,020	26,600	72,500	27,000	59,000	600,000	550,000
3,400	5,500	114,000	55,000	1,400	420	27,000	45,100	27,300	13,000	610,000	Uncountable.
3,600	12,600	130,000	450,000	1,450	1,360	27,900	23,500	28,200	147,000	700,000	12,000,000
3,700	16,280	141,000	120,000	1,500	1,160	28,400	17,520	31,000	30,000	700,000	490,000
3,800	2,400	152,000	192,000	1,520	10,180	31,000	36,000	31,000	Uncountable	840,000	Uncountable.
4,000	4,000	220,000	134,000	1,530	3,500	34,000	15,300	31,000	48,000	870,000	825,000
4,700	220	228,000	800,000	1,620	2,700	35,000	53,500	32,000	55,000	1,030,000	Uncountable.
4,700	2,020	282,000	1,150,000	1,680	5,460	38,000	20,000	32,000	35,000	1,100,000	2,000,000
* 5,000	1,120,000	285,000	1,100,000	1,730	1,600	39,000	5,500,000	33,000	3,000,000	1,130,000	Uncountable.
5,500	3,400	300,000	200,000	1,800	1,760	40,000	290,000	33,000	400,000	1,140,000	Uncountable.
5,600	4,620	400,000	1,050,000	1,800	800	45,000	1,350,000	34,000	45,500	1,190,000	Uncountable.
5,700	7,080	420,000	1,170,000	1,800	5,620	51,000	28,000	35,000	9,500	1,240,000	7,200,000
5,800	2,000	480,000	590,000	1,800	1,340	59,000	285,000	36,000	850,000	1,340,000	Uncountable.
6,100	4,400	650,000	585,000	1,860	2,145	75,000	4,850	39,000	35,000	1,510,000	Uncountable.
6,800	4,250	Uncountable.	40,000	1,860	40,000	77,000	885,000	39,000	220,000	1,720,000	1,600,000
7,000	4,540	Uncountable	640,000	2,080	47,000	78,000	54,300	39,000	13,000	1,940,000	Uncountable
7,700	5,360			2,090	2,060	78,000	45,000	41,000	141,500	1,960,000	Uncountable.
7,800	5,000,000			2,130	1,260	108,000	37,500	41,000	Uncountable.	2,190,000	Uncountable.
8,000	4,000			2,150	700	130,000	1,315,000	42,000	Uncountable.	2,600,000	2,300,000
8,200	5,660			2,210	1,910	140,000	3,500,000	43,000	5,500,000	2,620,000	Uncountable
8,500	22,800			2,240	2,260	157,000	5,500,000	45,000	645,000	2,700,000	Uncountable.
9,600	9,820			3,000	7,100	183,000	85,000	46,000	435,000	3,410,000	113,000
9,800	5,800			3,200	2,288	216,000	1,500,000	52,000	104,500	3,720,000	Uncountable.
9,900	21,200			3,300	1,640	250,000	500,000	53,000	51,000	4,630,000	Uncountable.
10,800	25,000			3,500	66,500	300,000	90,000	57,000	240,000		
11,200	6,200			3,500	3,020	350,000	2,500,000	62,400	65,000		
11,900	4,680			3,600	4,060	364,000	4,500,000	66,000	47,000		
11,900	8,200			3,600	3,800	500,000	229,000	68,000	800,000		
12,500	6,100			3,700	105,000	530,000	125,000	68,000	59,500		
12,900	80,000			3,700	2,980	650,000	3,500,000	74,000	1,195,000		

SUMMARY.

Estimates of the number of bacteria in milk which were made by Van Oijen's method appear to give results which are in reasonable agreement with those obtained by the standardized plate technique of the Ministry of Agriculture, provided the count does not exceed 30,000 per c.cm. The method is cheap, rapid and considerably reduces the amount of apparatus needed for each test, but does not include a result for coliform contamination.

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THE TREATMENT OF POULTRY EXPERIMENTAL DATA BY THE ANALYSIS OF VARIANCE METHOD

By H. B. Bescoby, P.A.S.I., N.D.A.
Department of Agriculture, S.E. Agricultural College, Wye, Kent.

Introduction.

The Analysis of Variance method (1) of treating experimental data is now being frequently employed. This paper illustrates the method as applied to the results of poultry trials in which the birds were fattened by trough feeding and cramming. The possibility of including large numbers of birds in the trial rendered it possible for the errors of the experiment to be kept low. In designing trials of this nature, the treating of the data is greatly facilitated if the same number of birds is used for each treatment and the same number of cockerels as pullets employed. If the numbers of each sex differ greatly and the interaction between the sexes and treatment is large, the errors of the experiment when combining cockerel and pullet weights will be affected. An important factor may be pointed out that if the birds are to be subjected to different treatments, it is necessary for the birds under one treatment to be divided into several groups and placed in separate pens. If the birds under one treatment are all run together they will be influenced by disease and other variations outside the actual trial and the results will not be satisfactory. One method which may be recommended is for the birds in each pen to be divided into as many groups as there will be treatments and for the pen and ark or house to be divided into as many sections by netting. Each treatment group will then be subjected to similar conditions (2). At least four pens should be included, then the errors between pens can be calculated in addition to the errors between the weights of individual birds ; in this way the results of the trial can be made more reliable. During the fattening period the birds may be placed at random in the crates. All through the experiment the birds should be numbered. It is very important that in poultry-fattening trials the time of the year at which they take place should be stated.

The Trial.

Light Sussex chicken were hatched at intervals of one month throughout the year of 1930. They were placed in hovers until eight weeks of age, from eight to fourteen weeks they were on runs, from fourteen to sixteen weeks being trough-fed in crates and from sixteen to seventeen weeks they were crammed. It has often been stated that birds fed on dry mash do not fatten as well as birds fed on wet mash. To test the accuracy of this statement the chickens when hatched were divided into three sections and fed as below up to fourteen weeks of age :—

A. Dry Mash + Wet Mash.
B. Dry Mash.
C. Wet Mash.

The birds were weighed individually at eight, fourteen, sixteen and seventeen weeks. In this paper the birds hatched at the same time are referred to as batches 1-12

and the birds in the batches but on different treatment are designated as groups. The following Table I gives the dates of hatching and weighing of the batches.

TABLE I.

Batches.	Date of Hatching.	8 weeks.	14 weeks.	16 weeks.	17 weeks.
1	27 Nov. 1929	22 Jan.	5 March	19 March	26 March
2	22 Dec. 1929	17 Feb.	31 March	14 April	21 April
3	22 Jan. 1930	19 March	30 April	14 May	21 May
4	17 Feb.	14 April	26 May	9 June	16 June
5	13 March	8 May	19 June	3 July	10 July
6	9 April	4 June	16 July	30 July	6 August
7	2 May	30 June	11 August	25 August	1 Sept.
8	4 June	30 July	10 Sept.	24 Sept.	1 Oct.
9	30 June	25 August	6 Oct.	20 Oct.	27 Oct.
10	25 July	19 Sept.	31 Oct.	14 Nov.	21 Nov.
11	18 August	13 Oct.	24 Nov.	8 Dec.	15 Dec.
12	10 Sept.	5 Nov.	17 Dec.	31 Dec.	7 Jan.

THE ANALYSIS OF RESULTS.

This trial was not designed as recommended in the introduction, the birds in each group being all in the same pen, but as the experiment was repeated every month the interaction between batches and rations could be calculated. The number of birds in each group varied and the number of cockerels differed from the number of pullets. This was a result of the difficulty of determining the sex before eight weeks of age (2). This latter factor has now been overcome by the use of sex linked chicken.

The result of this trial was mainly concerned with the fattening stages of fourteen to sixteen weeks and sixteen to seventeen weeks, therefore in analysing the results the weights at eight weeks for individual birds have not been included.

PULLET WEIGHTS AT EIGHT WEEKS (1,346 BIRDS).

Table II shows the mean weights of the groups, batches and ration groups throughout the year. The varying numbers of birds in each group has been ignored and all the

TABLE II.

Pullet Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	January ..	10·2	9·4	8·6	9·4	
2	February ..	11·6	11·2	10·9	11·2	
3	March	12·6	14·4	11·7	12·9	
4	April	16·6	15·3	14·1	15·3	
5	May	16·0	16·9	14·5	15·8	
6	June	16·8	16·7	14·9	16·1	
7	June	15·5	13·3	12·4	13·7	1·94
8	July	15·5	14·7	15·2	15·1	
9	August	14·7	15·0	13·3	14·3	
10	September ..	14·5	14·9	10·8	13·4	
11	October	14·9	12·7	12·3	13·3	
12	November ..	13·9	13·5	10·4	12·6	
	Means	14·4	14·0	12·4	13·6	
	Significant Difference ..	·73				

means are unweighted, so that the results are not affected by the large number of birds included in the trial at the time of the year when the birds reached the maximum weights (April to August). The significant difference for batch means and ration means gives a measure for the differences between the various means and is based on ·05 probability tables.

These figures indicate plainly that the wet mash produced smaller birds and that there were variations in weights at different times of the year. It is now required to test the possible accuracy of these results by the use of statistics.

By constructing an Analysis of Variance table it is possible to separate the amount of variation in weights due to the rations from that due to the batches.

(A) *Analysis of Variance.*

	Sum of Squares.	Degrees of Freedom.	Mean Square.	Standard Deviation.	½ log .	z	
Rations	26·01	2	13·01		2·4341	1·4471	} ·0630
Batches	126·15	11	11·47		2·3711	1·3841	
Interaction R × B	15·88	22	·72	·85	·9870		
Total	168·04	35					

Comparing the " z " figures with ·6182, ·4093 and ·6909 from Dr. Fisher's ·05 table (1), it will be seen that both rations and batches are showing significant differences over their interaction, but that there is no difference between the effects caused by the rations or the batches.

Taking " t " times the interaction difference between two means for the significant difference gives the figures stated in Table II (3, 4) and it will be seen that the wet mash at eight weeks produced definitely low weights, but there was no difference between the dry mash and dry + wet mash. The batch means indicate a definite variation at the different times of the year, the maximum weights being reached between April and August. Batch 7 is out of sequence and some other influence may have been the cause.

COCKEREL WEIGHTS AT EIGHT WEEKS (1,133 BIRDS).

TABLE III.

Cockerel Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	January ..	10·6	10·8	9·4	10·3	3·44
2	February ..	12·9	12·2	14·7	13·3	
3	March	11·8	15·8	12·0	13·2	
4	April	18·4	18·5	15·6	17·5	
5	May	17·1	18·5	15·4	17·0	
6	June	19·6	19·2	15·6	18·1	
7	June	15·9	15·2	14·3	15·1	
8	July	15·4	16·4	16·9	16·2	
9	August	15·7	16·5	17·8	16·7	
10	September ..	16·0	16·7	12·0	14·9	
11	October	17·4	15·3	13·1	15·3	
12	November ..	15·6	16·7	11·5	14·6	
	Means	15·5	16·0	14·0	15·2	
Significant Difference			1·29			

(B) *Analysis of Variance.*

	Sum of Squares.	Degrees of Freedom.	Mean Square.	Standard Deviation.	$\frac{1}{2}\log_e$.	z	·05z
Rations	25·25	2	12·62		1·2676	·8447	·62
Batches	158·65	11	14·42		1·3343	·9184	·41
Interaction R × B	51·16	22	2·33	1·53	·4229		
Total	235·06	35					

The rations and batches both give a significant difference over the interaction but there is no significance between them.

The significant difference was calculated as in the case of pullets. Again wet mash was inferior and maximum weights were reached between April and August.

COCKEREL AND PULLET WEIGHTS AT EIGHT WEEKS (2,479 BIRDS).

The extent to which the different sexes react to the rations may be calculated by making an Analysis of Variance of the mean weights of cockerels + pullets. The mean weights of the two sexes are given below :—

TABLE IV.

Cockerel and Pullet Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	January ..	10·40	10·10	9·00	9·83	
2	February ..	12·25	11·70	12·80	12·25	
3	March	12·20	15·10	11·85	13·05	
4	April	17·50	16·90	14·85	16·42	
5	May	16·55	17·70	14·95	16·40	
6	June	18·20	17·95	15·25	17·13	1·15
7	June	15·70	14·25	13·35	14·43	
8	July	15·45	15·55	16·05	15·68	
9	August	15·20	15·75	15·05	15·50	
10	September ..	15·25	15·80	11·40	14·15	
11	October	16·10	14·00	12·70	14·27	
12	November ..	14·75	15·01	10·95	13·60	
	Means	14·96	14·99	13·22	14·39	
	Significant Difference	·44				

(C) *Analysis of Variance. (Total of Cockerels and Pullets.)*

	Sum of Squares.	Degrees of Freedom.	Mean Square.
Rations	24·56	2	12·28
Batches	139·24	11	12·66
Interaction R × B ..	27·67	22	1·26
Total	191·47	35	

This Analysis of Variance can be taken a step further to calculate interactions and sex differences by constructing the following tables of means and treating them as randomized blocks :—

Rations.	Cockerels.	Pullets.
A	15·5	14·4
B	16·0	14·0
C	14·0	12·4
Means	15·2	13·6

Giving sex differences and interaction between sex and rations.

Batches.	Cockerels.	Pullets.
1	10·3	9·4
2	13·3	11·2
3	13·2	12·9
4	17·5	15·3
5	17·0	15·8
6	18·1	16·1
7	15·1	13·7
8	16·2	15·1
9	16·7	14·3
10	14·9	13·4
11	15·3	13·3
12	14·6	12·6
Means . ..	15·2	13·6

Giving interaction between batches and sex.

(D) The *Analysis of Variance* now becomes :—

	Sum of Squares.	Degrees of Freedom.	Mean Square.	Standard Deviation.	$\frac{1}{2}\log_e$.	z	·05z
Rations	24·56	2	12·28*		2·4028	1·9166	·6182
Batches	139·25	11	12·66*		2·4205	1·9243	·4093
Sex	22·32	1	22·32*		2·7040	2·2078	·7294
R × B	27·67	22	1·25*		1·2628	·7666	·3600
B × S	3·16	11	·29		·5323	·0361	·4093
R × S	1·06	2	·53		·8328	·3366	·6182
R × B × S ..	5·75	22	·27	·52	·4962		
Total	223·87	71					

* Indicates significant differences.

The rations, batches and sex show significance, as also does the interaction between rations and batches. Apparently the sexes did not react differently to the rations or the time of the year in which they are hatched.

The significant differences in Table IV are calculated from the second order interaction (R×B×S).

Sex.	Means.	Significant Difference.
Cockerels ..	15·2	·27
Pullets ..	13·6	
Mean ..	14·4	

At eight weeks the wet mash showed inferiority to the other two rations, there was no difference between the dry mash and the wet + dry mash and the cockerels definitely weighed heavier than the pullets. The maximum weights were reached in April, May, June, July and August. Batch 7 (June) appears to have been a poor batch, and was significantly lower than Batch 6.

Pullet Weights at Fourteen Weeks (after Six Weeks on the Run), (1,153 birds).

At this age the weights of the individual birds have been taken into consideration and the rations and batches tested against the error within pens. The analysis has been performed on the mean bird weights on the assumption that each mean has an equal variance, the error variance being taken as the mean of the variances of the various mean bird weights (2).

Table V.

Pullet Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	March	27·8	24·3	27·3	26·5	1·75
2	March	33·8	32·5	33·3	33·2	
3	April	33·9	34·8	34·8	34·5	
4	May	44·2	40·4	42·2	42·3	
5	June	41·8	41·0	42·2	41·7	
6	July	42·5	38·6	41·1	40·7	
7	August	42·6	38·5	40·5	40·5	
8	September ..	38·1	33·6	38·8	36·8	
9	October	40·9	35·7	37·9	38·2	
10	October	35·2	32·1	30·5	32·6	
11	November ..	30·3	25·8	31·1	29·1	
12	December ..	30·3	28·0	29·3	29·2	
	Means	36·8	33·8	35·8	35·4	
	Significant Difference ..		·82			

(E) *Analysis of Variance.*

	Sum of Squares.	Degrees of Freedom.	Mean Square.	Standard Deviation.	½ $\log_e$.	z	·05z
Rations	56·08	2	28·04*		1·6668	1·6569	·55
Batches	968·28	11	88·03*		2·2388	2·2289	·33
Interaction R × B	36·63	22	1·66	1·29	·2538	·2439	·27
Intra Pen Error		1,117	1·02	1·00	·0099		
Total	1,060·99	1,152					

* Indicates significant differences.

The rations and batches show significance against their interaction and the intra pen error. There is no significance between rations and batches.

In this Analysis of Variance there is no significance between the interaction and the intra pen error, therefore the rations and batches variances have been measured against the intra pen error.

At the end of fourteen weeks the ration consisting of wet + dry mash gave the heaviest weights and the dry mash the lowest. Therefore during the eight to fourteen week period the birds on wet mash must have put on more weight than those on dry mash and have made up the deficiency at eight weeks. The maximum weights were reached between May and August. Batch 7 has recovered from a poor start at eight weeks. Batch 8 is low and this may have been due to a dry and very hot August.

COCKEREL WEIGHTS AT FOURTEEN WEEKS (AFTER SIX WEEKS ON THE RUN) (1,036 BIRDS).

TABLE VI.

Cockerel Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	March	32·8	29·3	31·9	31·3	
2	March	41·5	37·4	46·0	41·6	
3	April	41·4	45·5	44·0	43·6	
4	May	53·7	51·8	53·0	52·8	
5	June	51·9	47·8	51·6	50·4	
6	July	51·9	49·7	48·0	49·9	6·05
7	August	50·6	45·8	50·9	49·1	
8	September	43·3	40·7	45·3	43·1	
9	October	46·8	44·7	50·2	47·2	
10	October	44·1	37·0	36·6	39·2	
11	November	43·6	33·0	36·2	37·6	
12	December	38·3	37·0	32·6	36·0	
	Means	45·0	41·6	43·9	43·5	
	Significant Difference		2·26			

(F) *Analysis of Variance.*

	Sum of Squares.	Degrees of Freedom.	Mean Square.	Standard Deviation.	½ $\log_e$.	z	·05z
Rations	69·68	2	34·84*		1·7754	·7912	·6182
Batches	1,447·41	11	131·58*		2·4397	1·4555	·4100
Interaction R × B	157·48	22	7·16	2·68	·9842		
Intra Pen Error		1,000	2·74	1·66			
Total	1,674·57	1,035					

* Indicates significant differences.

In this Analysis of Variance the interactions between rations and batches is significantly greater than the intra pen error, therefore some outside influence had

affected the cockerels, and the rations and batches have been measured against their interaction and not against the intra pen error. The significant differences are therefore high, but the cockerels still give the same results as the pullets, dry mash being inferior to the other two rations. Batch 8 gives a low mean and Batch 7 has recovered from the low weights at eight weeks. The heaviest weights were reached between May and August.

COCKEREL AND PULLET WEIGHTS AT FOURTEEN WEEKS (AFTER SIX WEEKS ON THE RUN) (2,194 BIRDS).

TABLE VII.

Cockerel and Pullet Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	March	30·3	26·8	28·6	28·9	
2	March	37·6	39·9	39·6	37·4	
3	April	37·6	40·1	39·4	39·1	
4	May	48·9	46·1	47·6	47·5	
5	June	46·8	44·4	46·9	46·0	
6	July	47·2	44·1	45·5	45·3	2·88
7	August	46·6	42·1	45·7	44·8	
8	September	40·7	37·1	42·0	39·8	
9	October	43·8	40·2	44·0	42·7	
10	October	39·6	34·6	33·5	35·9	
11	November	36·9	29·4	33·6	33·3	
12	December	34·3	32·5	30·9	32·6	
	Means	40·9	37·7	39·8	39·5	

Significant Difference .. 1·08

(G) *Analysis of Variance.*

	Sum of Squares.	Degrees of Freedom.	Mean Square.	Standard Deviation.	½ $\log_e$.	z	·05z
Rations	62·69	2	31·39*		1·7232	1·4789	·62
Batches	1,186·95	11	107·40*		2·3382	1·0939	·41
Sex	584·83	1	584·83*		3·1857	2·9414	·73
R × B	61·19	22	2·78		·5112	·2669	·41
B × S	20·89	11	1·90		·3208	·0765	
R × S	·19	2	·09		—		
R × B × S	35·86	22	1·63		·2443		
Total	1,952·60	71					

* Indicates significant differences.

As the cockerels gave a definite interaction between rations and batches the interaction between rations, batches and sexes is used in this analysis to measure significance.

Sex.	Means.	Significant Difference.
Cockerels	43·5	·66
Pullets	35·4	
Mean ..	39·5	

At fourteen weeks the difference between cockerel and pullet weights was large. Rations, batches and sex gave significance over their interaction. Apparently the sexes did not react differently to the rations or the time of year of hatching. Maximum weights were reached between May and August. Batch 7 is shown to have recovered and Batch 8 shows a decline probably due to the temperature being over 85° for a week in August. The increased weight of Batch 9 may have been due to a secondary growth of grass in September. The rations fed did not affect the weights of the birds as much as they were affected by the time of year of hatching.

Pullet Weights at Sixteen Weeks (after Fourteen Days Trough Fed in Crates) (612 birds).

Table VIII.

Pullet Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	March	38·40	37·39	36·41	37·40	1·32
2	April	44·95	43·47	45·75	44·72	
3	May	45·25	43·97	44·73	44·65	
4	June	49·56	48·25	47·41	48·41	
5	July	47·14	48·97	48·47	48·19	
6	July	49·03	46·67	47·80	47·83	
7	August	50·33	45·79	48·14	48·09	
8	September ..	45·46	43·03	47·98	45·49	
9	October	50·64	47·04	47·67	48·45	
10	November ..	46·43	43·30	38·97	42·90	
11	December ..	39·31	37·46	43·57	40·11	
12	December ..	43·33	39·52	41·97	41·61	
	Means	45·82	43·74	44·91	44·82	
	Significant Difference ..		·66			

(H) *Analysis of Variance.*

	Sum of Squares.	Degrees of Freedom.	Mean Square.	½ $\log_e$.	z	·05z
Rations ..	26·11	2	13·05*	1·2843	·8143	·55
Batches	446·64	11	40·60*	1·8519	1·3819	·33
R × B	71·41	22	3·25	·5893	·1193	·27
Intra Pen Error		576	2·56	·4700		
Total	544·16	611				

* Indicates significant differences.

There is no significance between the interaction and the intra pen error, and the intra pen error has been used to measure significance. The wet + dry mash gave higher weights than the other two rations and the dry mash was better than the wet mash. Batch 7 maintained its position but Batch 8 showed the effect of the decreased weight at fourteen weeks. Batch 9 was still high. Maximum weights were reached between June and October.

COCKEREL WEIGHTS AT SIXTEEN WEEKS (AFTER FOURTEEN DAYS TROUGH FED IN CRATES) (539 BIRDS).

TABLE IX.

Cockerel Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	March	47·16	45·35	44·08	45·53	
2	April	55·62	50·38	60·50	55·50	
3	May	53·20	59·34	55·71	56·08	
4	June	61·45	63·40	59·50	61·45	
5	July	63·88	58·83	54·13	58·95	
6	July	59·61	57·03	51·91	56·18	
7	August	58·39	53·94	61·36	57·90	5·49
8	September	53·69	48·76	54·67	52·37	
9	October	57·75	55·33	62·75	58·61	
10	November	57·74	51·78	49·08	52·87	
11	December	56·82	48·50	49·64	51·65	
12	December	51·25	49·35	49·21	49·94	
	Means	56·39	53·50	54·38	54·76	
	Significant Difference		2·05			

(I) *Analysis of Variance.*

	Sum of Squares.	Degrees of Freedom.	Mean Square.	½ $\log_e$.	z	·05z
Rations	52·31	2	26·15	1·6319	·4214	·62
Batches	655·98	11	59·63*	2·0441	·8336	·41
R × B	267·70	22	11·26	1·2105		
Intra Pen Error		503	5·90			
Total	975·99	538				

* Indicates significant differences.

The interaction is significantly larger than the intra pen error, and therefore the interaction has been used to measure significance. Batches show significance and, as was the case with the pullets, the time of the year of hatching had more influence than any of the rations fed.

COCKEREL AND PULLET WEIGHTS AT SIXTEEN WEEKS (AFTER FOURTEEN DAYS TROUGH FED IN CRATES) (1,151 BIRDS).

TABLE X.

Cockerel and Pullet Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	March	42·78	41·37	40·24	41·46	4·05
2	April	50·28	46·92	53·12	50·11	
3	May	49·22	51·65	50·22	50·34	
4	June	55·50	55·82	53·46	54·76	
5	July	55·51	53·90	51·30	53·57	
6	July	54·32	51·85	49·85	52·01	
7	August	54·36	49·87	54·75	52·99	
8	September ..	50·42	45·89	51·37	48·93	
9	October	54·19	51·18	55·22	53·53	
10	November ..	52·09	47·54	44·03	47·88	
11	December ..	48·06	42·93	46·60	45·88	
12	December ..	47·29	44·44	45·59	45·77	
	Means	51·10	48·62	49·64	49·79	
Significant Difference ..			1·51			

(J) *Analysis of Variance.*

	Sum of Squares.	Degrees of Freedom.	Mean Square.	½ $\log_e$.	z	·05z
Rations	37·47	2	18·73*	1·4650	·8897	·62
Batches	882·69	11	55·70*	2·0100	1·5957	·41
Sex	526·05	1	526·05*	3·1326	2·7183	·73
R × B	99·92	22	4·95	·7997	·2244	·36
B × S	25·25	11	2·29	·4143	—	·41
R × S	1·74	2	·87			
R × B × S ..	69·62	22	3·16	·5753		
Total	1,642·74	71				

* Indicates significant differences.

Rations, batches and sex show significance. The sex difference is large and the batches variance is larger than the ration variance. The sexes were not affected differently by the rations or the time of the year of hatching.

Sex.	Means.	Significant Difference.
Cockerels ..	54·76	·84
Pullets ..	44·82	
Mean ..	49·79	

These means prove the cockerels to weigh about 10 oz. more at sixteen weeks than the pullets.

Wet + dry mash produced heavier weights than the other two rations. The maximum weights were produced between June and August. Batch 8 was low and Batch 9 high maintaining the gain made when on the run.

PULLET WEIGHTS AT SEVENTEEN WEEKS (AFTER SEVEN DAYS CRAMMING) (614 BIRDS).

TABLE XI.

Pullet Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	March	40·52	39·06	39·87	39·82	
2	April	52·27	50·00	51·25	51·17	
3	May	50·95	50·53	50·36	50·61	
4	June	55·61	57·19	55·24	56·01	
5	July	56·44	55·69	58·00	56·71	
6	August	55·12	55·40	54·68	55·07	3·08
7	September ..	54·03	50·52	50·02	51·52	
8	October	49·76	50·10	54·25	51·37	
9	October	55·57	54·07	50·81	53·48	
10	November ..	48·43	49·25	43·06	46·91	
11	December ..	46·31	43·27	47·57	45·72	
12	January ..	47·67	44·46	46·41	46·18	
	Means	51·06	49·96	50·13	50·38	

Significant Difference .. 1·54

(K) *Analysis of Variance.*

	Sum of Squares	Degrees of Freedom.	Mean Square.	$\frac{1}{2}\log_e$	z	·05z
Rations	8·36	2	4·18	·7151	·0760	·55
Batches	808·08	11	73·46*	2·1483	1·5092	·32
R × B	72·16	22	3·28	·5939	—	·27
Intra Pen Error		578	3·59	·6391		
Total	880·60	613				

* Indicates significant difference.

There was no significant difference between the interaction and the intra pen error. The rations show no significant difference but there is significance between the batches. The maximum weights were reached in June, July and August. Batch 7 was crammed during a week's very hot weather. Batch 8 remained low as a result of the check when on the run and Batch 9 maintains high weights compared with Batch 10.

COCKEREL WEIGHTS AT SEVENTEEN WEEKS (AFTER SEVEN DAYS CRAMMING) (539 BIRDS).

TABLE XII.

Cockerel Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	March	52·11	50·67	49·92	50·90	5·89
2	April	66·02	59·92	68·86	64·93	
3	May	63·27	72·03	65·82	67·04	
4	June	71·38	77·01	69·62	72·67	
5	July	76·35	70·41	66·16	70·97	
6	August	69·20	70·47	63·45	67·71	
7	September ..	62·45	62·56	64·64	63·22	
8	October	61·14	59·58	63·87	61·53	
9	October	65·86	66·24	70·08	67·39	
10	November ..	62·71	58·00	55·08	58·60	
11	December ..	67·29	57·36	56·25	60·30	
12	January ..	59·91	59·00	54·78	57·90	
	Means	64·81	63·60	62·38	63·60	

Significant Difference ..

(L) *Analysis of Variance.*

	Sum of Squares.	Degrees of Freedom.	Mean Square.	½ log$_e$.	z	·05z
Rations	35·43	2	17·72	1·4373	·1286	·62
Batches	1,247·01	11	113·36*	2·3653	1·0566	·41
R × B	301·47	22	13·70	1·3087		
Intra Pen Error		503	6·74			
Total	1,583·91	538				

* Indicates significant difference.

Comparing the rations and batches with their interaction the ration differences have no significance, but the batches differences have significance. As was the case with the pullets, Batches 7 and 8 were low and Batch 9 high.

COCKEREL AND PULLET WEIGHTS AT SEVENTEEN WEEKS (AFTER SEVEN DAYS CRAMMING) (1,153 BIRDS).

TABLE XIII.

Cockerel and Pullet Weights in Ounces.

Batch.	Month Weighed.	A	B	C	Mean.	Significant Difference.
1	March	46·32	44·87	44·90	45·36	
2	April	59·14	54·96	60·05	58·05	
3	May	57·11	61·28	58·09	58·83	
4	June	63·49	67·10	62·43	64·34	
5	July	66·40	63·05	62·08	63·84	
6	August	62·16	62·93	59·07	61·39	
7	September ..	58·24	56·54	57·33	57·37	4·33
8	October	55·45	54·84	59·06	56·45	
9	October	60·72	60·16	60·44	60·44	
10	November ..	55·07	53·62	49·07	52·75	
11	December ..	56·80	50·32	51·91	53·01	
12	January ..	53·74	51·73	50·59	52·04	
	Means	57·93	56·78	56·25	56·99	
	Significant Difference ..		1·62			

(M) *Analysis of Variance.*

	Sum of Squares.	Degrees of Freedom.	Mean Square.	½ $\log_e$.	z	·05z
Rations	17·71	2	8·85	1·0902	·4388	·62
Batches	992·27	11	90·20*	2·2510	1·5996	·41
Sex	1,571·66	1	1,571·66*	3·6801	3·0287	·73
R × B	100·92	22	4·58	·7608	·1094	·36
B × S	35·62	11	3·25	·5893		
R × S	3·70	2	1·60	·2350	—	
R × B × S ..	86·00	22	3·68	·6514		
Total	2,807·88	71				

* Indicates significant differences.

Compared with their interaction, batches and sex show significance. The sexes were responsible for the majority of the variation. The maximum weights were reached from June to October, Batches 7 and 8 were low and Batch 9 high.

Sex.	Means.	Significant Difference.
Cockerels..	63·60	·90
Pullets ..	50·38	
Mean ..	56·99	

The final weights of the cockerels were about 13 oz. heavier than those of the pullets.

Conclusions.

The averages for the whole year of the unweighted group means were :—

	Cockerels.	Pullets.	Mean.
8 weeks	15·2	13·6	14·4
14 weeks	43·5	35·4	39·5
16 weeks	54·8	44·8	49·8
17 weeks	63·6	50·4	57·0

The actual increases in weight for the whole year between the ages of weighing were :—

	Cockerels.		Pullets.	
	per period.	per day.	per period.	per day.
8-14 weeks (on the run) ..	28·3	·67	21·8	·52
14-16 weeks (trough fed) ..	11·3	·81	9·4	·67
16-17 weeks (crammed)	8·8	1·26	5·6	·80

These actual increases per day expressed as percentages of the mean weights of the periods were :—

	Cockerels.	Pullets.
8-14 weeks ..	2·2867%	2·1224%
14-16 weeks ..	1·6480%	1·6708%
16-17 weeks ..	2·1284%	1·6807%

In proportion to their weight the cockerels made a greater increase than the pullets when on the run and being crammed, but not during trough feeding. It is hoped that the increases in weight treated by their regression coefficients may be dealt with later.

Interactions.

The standard deviations of the interactions between rations and batches were :—

	Cockerels.	Pullets.
8 weeks	1·53	·85
14 weeks	2·68	1·29
16 weeks	3·36	1·80
17 weeks	3·70	1·44

These expressed as percentages of the mean weights were :—

	Cockerels.	Pullets.
8 weeks	10·00%	6·25%
14 weeks	6·16%	3·64%
16 weeks	6·13%	4·01%
17 weeks	5·81%	2·52%

The variation between pens was large, especially for cockerels, and therefore the error within pens could not be used as it might have been if the experiment had been designed as previously stated, dividing the pen variations among the different treatments. If the between-pen differences are larger than the within-pen differences then there must have been some outside influence such as disease or position, responsible for the excess variation. The standard deviations of the means within pens were :—

	Cockerels.	Pullets.
14 weeks	1·66	1·00
16 weeks	2·43	1·60
17 weeks	2·60	1·89

These expressed as percentages of their mean weights were :—

	Cockerels.	Pullets.
14 weeks	3·81%	2·82%
16 weeks	4·43%	3·57%
17 weeks	4·08%	3·75%

The cockerel weights show a greater variability than the pullet weights. During the investigation of the data the wet mash showed a greater variation in bird weights than the other two rations, and the dry mash was the most consistent.

RATIONS.

At eight weeks of age the birds fed on wet mash were inferior to those fed on the other two rations but at fourteen weeks they were about the same weight as those on wet + dry mash. At fourteen weeks the birds on the dry mash resulted in the lowest weights : this was especially noticeable between May and October. At sixteen weeks the wet + dry mash gave the heaviest birds, with those on dry mash still tending to be the lowest. The weights at seventeen weeks indicate that the three rations were not affecting ultimate weights of the birds to any marked extent.

BATCHES.

These represent the different times of the year at which the birds were reared. At all ages it was seen that the highest weights were obtained from the birds hatched in February, March and April. At eight weeks Batch 7 was low.

The batches at the beginning and the end of the year were consistently low at all ages. At fourteen weeks Batch 7 had recovered but Batch 8 was low as the month of August was very hot and dry, the temperature being well over 80° F. This had a retarding effect on growth especially noticeable on the birds which were being crammed during the very hot week at the end of August. At the end of sixteen weeks Batch 8 was still showing low weight and Batch 9 held the advantage gained at fourteen weeks. At the final weights of seventeen weeks, Batch 7 was low as this was the batch of birds being crammed at the end of August ; Batch 8 also was low.

It would appear that extremes of temperature are detrimental to the growth of chickens, although this is not the entire cause as the birds which were in the hovers at

an even temperature showed lower weights in the winter months. Probably length and intensity of sunshine have also an effect. The increase in weight of Batch 9 after being on the run is interesting and it is possible that as grass growth in the spring is beneficial, the secondary grass growth or aftermath which in 1930 took place in September may have been responsible for the better growth of the birds. This advantage was held until the end of the seventeen weeks. When grass growth was correlated with weights at fourteen weeks the correlation was almost perfect. Several more years' data must be investigated before coming to definite conclusions, as it may be that all the factors (rain, humidity, sun and temperature, etc.) which lead to grass growth are the same factors required for good chicken growth.

SUMMARY.

A trial in 1930 was undertaken to test the general opinion that chickens fed on dry mash up to fourteen weeks of age would not fatten as well as chickens fed on wet mash. The figures obtained prove that there is no truth in the assertion, the dry mash birds at the end of seventeen weeks having put on as much weight as those on wet mash.

The results of rearing birds at various times of the year have been discussed relating to the affect of temperature and grass growth. It is shown that birds weighed in May to September attained heavier weights than those weighed during the winter months. Extremes in temperature retarded growth rate.

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THE FIELD EXAMINATION OF THE NATURAL DRAINAGE OF SOILS

By Basil S. Furneaux, M.Sc., Dip. Agric. (Wye).

If an excuse be necessary for considering some of the factors involved in the natural drainage of the soil, it is to be found in the increasing interest which is being taken in the examination of soils in the field as distinct from laboratory practice. Not many years ago work of the soil scientist in the field was limited and the collection of samples for analysis in the laboratory later. But the recognition of the Soil-Profile has changed that. More important than laboratory investigation is the examination of the soil *in situ*, for without this, laboratory work is of little value. The American method of soil surveying which is now almost universally accepted was described by Lee (1930). This method attaches great importance to natural drainage in the establishment and identification of soils series. For example, two soils composed of identical materials but having a difference of drainage, are placed in separate series. This is justified by experience, which shows that in the majority of soils differences in the water circulation produce marked contrasts in cropping capacity.

Drainage is usually described by the use of the words " good " and " bad," but it must be evident that there is a very wide range of intermediates between the very excessively drained and the fully waterlogged ; between the desert and the swamp. Fortunately, in England the desert end of the scale hardly concerns us. But this does not imply that there are no soils in this country which exhibit excessive natural drainage. It is unfortunate that the application of the words " excessive," " good " and " bad " is so vague in its meaning. It is naturally asked, " good " for what or " bad " for what ? A grower of osiers may not interpret words as a farmer growing barley does. The truth is that every plant has its own particular water requirements and, other things being equal, will grow best in the soil which most nearly meets those requirements. That these conditions are capable of modification to a certain extent is true. But the man whose soil is suited by nature to the crop he grows upon it, is obviously the most likely to achieve financial success as a reward of his labours.

In the title of this paper the word drainage is perhaps a little liable to misinterpretation, for natural drainage does not merely result in the removal of surplus water from the soil. The reversal of that process, by which moisture is supplied to the soil at times when there is no rain, is all part and parcel of the same thing. The name water circulation provides a better picture of the whole, but its less universal use is a disadvantage to its employment. When one is called upon to define the degree of drainage called " good," the whole indefiniteness of such a nomenclature shows up clearly. One can only offer some imperfect attempt such as : that it is the state of drainage which allows of the rapid removal of surplus water from the soil, while at the same time retaining sufficient for satisfactory plant growth. Then there are the soils which fall on both sides of this ideal.

It is easy enough, with a certain amount of practice, to recognize as such, soils in which the drainage is defective even during dry periods. Deficiency of drainage may,

however, be due to a number of causes which, as might be expected, produce different effects Briefly the causes may be set out under three heads :—

(i) Impermeability of the soil or rock.
(ii) Discharge of water from springs into the soil
(iii) Presence of a water-table near the surface

The first cause is undoubtedly the commonest Wide areas of land are often badly drained because the rain is unable to soak away readily This may be due to the presence of an impermeable geological material beneath the soil, such as clay or granite.

Fig 1

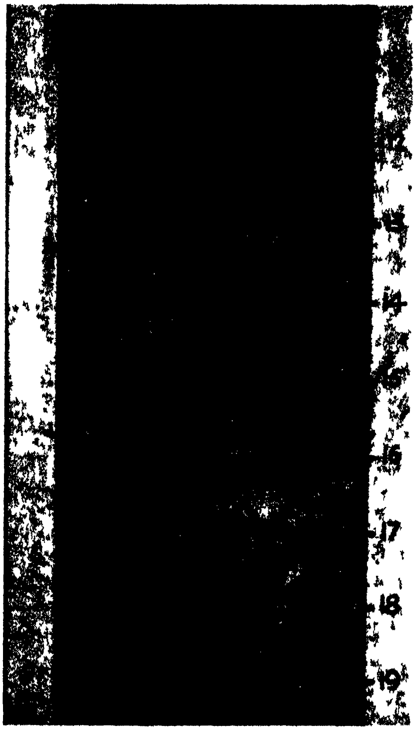

Fig 2

Fig 1 — A section (*soil-profile*) through a badly drained soil Iron accumulation is visible as a number of small dark concretions in that portion of the soil which lies between the marginal marks Bad drainage due to poor penetrability is also indicated in this soil by mottling, which extends right to the surface, but is too fine to be visible in the photograph

Fig 2 —The part of the *soil-profile* which is indicated by the marginal marks of Fig 1 On the right of Fig 2 is a scale in inches to indicate the depth from the surface The iron accumulation is most easily seen on the left-hand side opposite the numbers 16 and 17

The obstruction to drainage may, however, be a pan in the soil itself, due either to the deposition in its lower horizons of iron or clay or even to the compact nature of the soil itself Many degrees of deficiency are produced by this cause according to the degree of impermeability encountered. A soil overlying clay may be expected to show more marked signs of poor drainage than one in which the obstruction is produced by a compact horizon of illuviation overlying a pervious rock. A slope certainly improves

matters by allowing surface water to run away readily, but so often it is associated with erosion which has produced a shallow soil. The effect of erosion in the case of a soil containing a more or less impervious horizon or overlying an impervious rock is, of course, to bring the impervious material closer to the surface. It is not uncommon, therefore, in certain districts, to find slopes associated with the worst drained soils. The depth of the obstruction to the passage of water is important ; the further it is from the surface the more freely-draining material there is above it, in which roots may run without suffering asphyxiation from waterlogging.

Obstructions to drainage of this type have also the effect of rendering the soil liable to dry out badly during times of drought. Where the rock beneath is impervious it does not afford a reservoir to be drawn upon as evaporation proceeds. Similarly, where there is a pan or compact horizon, this may be just as great an obstacle to the upward movement of water as to its downflow.

Transported soils, as a class, are far less liable to this type of deficient drainage than sedentary soils, being usually far less compact and often, when deep, coarser in the lower part.

The discharge of spring water into the soil occurs where the rocks below contain pervious strata overlying impervious rocks, the water which freely penetrates the one being thrown out at the surface on reaching the other. This effect is far more common than might be supposed, but since the water is discharged into the soil it often runs through its deeper layers without being noticeable at the surface. However, this is by no means always the case ; sometimes a distinctly boggy patch or a stream may be produced. The effect of such a surface spring on the vegetation is obvious, but that of the unseen deeper moving water is often no less important to the farmer, and may account for many peculiarities of cropping hitherto unexplained.

Drift soils overlying rocks not very readily penetrable are most commonly possessed of such a flow of water through their lower horizons, and under such circumstances this condition may be found over quite large areas.

A water-table is present in the majority of pervious rocks, but it only becomes of importance in the study of the soil, where it is sufficiently near the surface for plants to make use of it. The seasonal variations in the height of the water-table may be so slight that there is a permanent supply of water near the surface, but, more often, fluctuation of the water level brings it near to or above the surface only at certain periods. The roots of many plants are not capable of withstanding protracted periods of immersion in water and hence the extent and frequency of such fluctuations are important factors in determining the cropping of the soil. Where large areas of soil are under the influence of a water-table, such as in Romney Marsh, this is controlled by artificial drainage and pumping so as to maintain the water-table at a satisfactory level. In the valleys of rivers, however, the water-table is usually not controlled and as the river rises so does the water in the alluvial soil which borders it. And naturally, if the water rises sufficiently the ground is flooded.

Fortunately, impeded drainage and the passage of spring water into the soil leave such easily recognizable clues that they may be detected in the soil even during dry periods. The commonest of these clues and the one most easily seen is the presence of numerous concretions of oxides of iron. The concretions are generally chocolate brown in colour but may be orange brown stained, producing an effect reminiscent of iron rust. The concretions are rounded and their size may be anything up to that of a pea. In

extreme cases numbers of them become cemented together into large lumps a foot or more in length, generally resulting in the production of an iron pan* which still further adds to the obstruction to the passage of water. If they are very small they are often most easily seen where a spade or auger has cut through the soil and smeared them into a number of chocolate brown streaks. A warning is necessary, however, that these concretions must be distinguished from decaying pieces of organic matter, present in some soils in considerable quantities. These are black, having the appearance of soft charcoal, and are irregular in shape They are very easily broken and have none of the rusty appearance of the concretions. There is also a danger of fine gravel consisting of

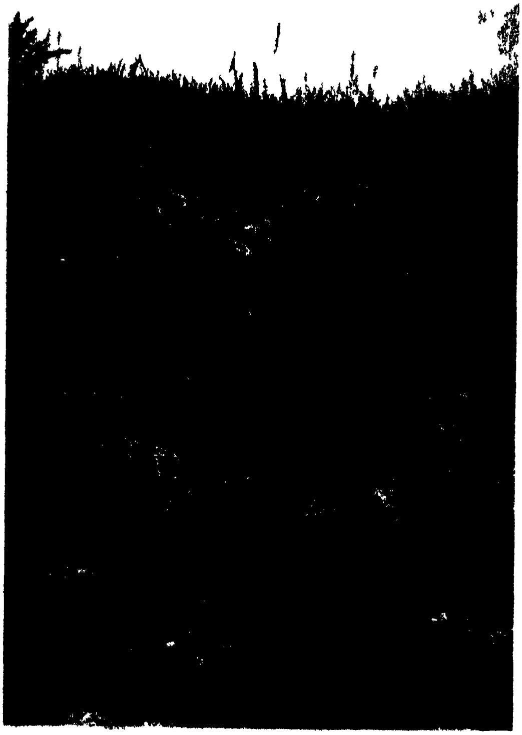

Fig. 3—A transported soil showing a heavy accumulation of iron from water passing through the gravelly lower horizons

water-worn pieces of iron stone or limonite being mistaken for concretions, but if one of these be split its true identity is readily revealed. Iron oxide concretions have various names in different parts of the country, the two most commonly used appearing to be "crowstone" and "shrave." The word "catsbrains" is also sometimes used in this connection though it is not to be recommended, as it is also applied to certain mottled clays (Topley, 1875). Fragments of sandstone or chert in the soil may provide nuclei for the deposition of the iron and sometimes become impregnated with a rusty deposit, in which they have the same significance as "crowstone" concretions.

* This type of pan is quite distinct from that found in highly podsolized soils.

These concretions appear to mark the horizon in which the hold-up of the water takes place ; in the compact horizon of a soil, just above a seam of impervious rock or at a point at which the water-table remains for considerable periods. Below this point the soil may become once more quite free from such iron deposition. Caution must be exercised in the interpretation of the concretions as a guide to the extent of drainage deficiency, in view of the differences of iron content which soils naturally possess. Also, in the case of soils supplied with spring water, the water itself may be carrying iron and depositing quantities out of all proportion to the extent of the deficiency in the drainage. Occasionally a drift soil is encountered, in which the iron is distributed as a dark chestnut brown to orange brown colouring matter in the soil and is not aggregated into concretions. This is produced by spring water. It may, however, be

Fig 4.—A well drained soil showing an even colouration and absence of iron oxide concretions

assumed that, in the absence of any other evidence of poor drainage, water penetrates the soil freely as far as the point at which the uppermost concretions are found.

Evidence of defective drainage is also supplied by the presence of mottling in the soil, often containing shades of blue, blue-grey or blue-green. Air is excluded from the soil by water filling the spaces between the soil particles, and the iron is reduced to ferrous compounds, which produce these characteristic colours. Such colours are therefore associated with waterlogging, although it must be borne in mind that shades of blue occur in many clays. But clay only retains a blue colour so long as it is unweathered and the presence of unweathered clay in the soil is an undesirable symptom, and may of itself be evidence of the exclusion of air by waterlogging. Except sometimes in the deeper horizons of the soil, the blue colour does not appear as a plain single shade

but mixed with dull orange or orange brown to produce a finely mottled effect. It is important to be watchful for this, as the general colour of the soil may appear a normal uniform brown or grey-brown of a well drained soil until it is examined closely, when its mottled nature becomes apparent. Mottling of any kind in the soil requires close examination so as to distinguish that which is due to defective drainage from that which is due to the presence of a mottled geological material. It is often not nearly so readily seen as the iron concretions and yet is, if anything, an even more important symptom of bad drainage, being generally associated with the worst drained soils. The mottling may extend to the surface of the soil and in such a case is indisputable

Fig. 5.—A soil possessing excessive drainage owing to its coarse open texture.

evidence of the waterlogging of the soil during at least a part of the year. As with the concretions, the depth of unmottled soil above that which is mottled is important, since every inch of well drained soil provides a favourable root run. Mottling such as has just been described may or may not be associated with concretions in the same soil, though in the more extreme cases of waterlogging, concretions are frequently absent, their place being taken by rusty stains.

A point of importance is that whereas artificial draining largely removes the blue and brown mottlings from a soil and leaves it with the even colour of a well drained soil, the concretions are more or less permanent and may remain for many years as evidence of the natural drainage capacity of the soil. This is important to the soil

surveyor, since the almost permanent nature of the concretions makes them important characters on which to base and identify soil series.

Excessive drainage is usually due to the presence, beneath the soil, of an open-textured rock such as a coarse sand or gravel, or of a much fissured rock such as limestone through which water may pass to a depth. As has been mentioned in the consideration of the causes of bad drainage, an impermeable rock, while producing wet conditions during times of rainfall, will cause severe drying out during rainless periods. Excessive drainage does not produce in the soil such obvious evidence as poor drainage; clues must therefore be sought in the examination of the underlying geological material. Cases of excessive drainage are often associated with shallowness of soil, which is of itself an undesirable character liable to produce poor growth in plants. Thus in many cases the one may be taken as evidence of the other. It may be added here that

Fig. 6—A soil only four inches deep, which is excessively drained on account of its shallowness

16 to 30 inches is the normal range of depth of sedentary soils in many parts of England. Soils shallower than this must be suspected of having been eroded or to have been incompletely weathered for one reason or another. It is stating an obvious fact to say that if the drainage is quite free, the deeper the soil the better it will retain water. It therefore stands to reason that under circumstances likely to produce excessive drainage the deeper drift soils should show the best powers of retention.

Only a very broad consideration of the economic effects of water circulation is possible because this is a study which is yet in its infancy. In England the collection of data is proceeding as a part of the soil survey work, but the amount of data to be collected is colossal. Not only does every crop have its own likes and dislikes, but each of its varieties will exhibit its own reactions to different conditions of water circulation. A few general statements may, however, be admissible even in the very immature state of our knowledge, since these are set down rather as illustrations than as a guide to the assessment of the economic value of soils.

Grass may be taken as the first example, since it is the most important and widespread crop in England. The writer has observed throughout the south-eastern part of the country that the majority of the best pastures show signs of impediment of drainage at a moderate depth from the surface. Such signs are comparatively slight but nevertheless well marked: their depth is dependent on a number of circumstances, but 18 to 30 inches may be taken as an example. This indicates a reasonable depth of freely drained soil and then at an easily accessible depth a supply of water. These conditions produce a good bulky herbage and would be suitable for a number of other crops requiring to make vigorous growth such as hops and root crops, but the tendency, under such conditions, would be for corn to make too much straw and "go down" badly. Similarly an apple tree would be forced into excessive growth, while under these same conditions a cherry tree, a lover of perfect drainage, would soon give up the attempt to grow at all.

The foregoing examples are intended solely to indicate the necessity for the consideration of the water conditions when deciding the suitability of the soil for any particular crop. Too long it has been the custom to think of the soil in terms of plant food alone and ignore all but the most obvious extremes of natural drainage. Deficiencies in plant foods can usually be made good by manuring, but deficiencies in the water circulation are harder to remedy and usually less thoroughly remediable. It is therefore an important matter to be able to recognize, in the field, under any conditions of moisture or drought, the characteristics of the natural water circulation in any particular soil.

SUMMARY.

The importance of the natural drainage in the examination of soils in the field is stressed. Defective drainage is presented as being due to three causes: (i) the impermeability of the soil or rock; (ii) the discharge of water from springs into the soil and (iii) the presence of a water-table close to the surface. The evidence of bad drainage to be seen in the soil is two-fold; in the presence of bluish-grey and dull orange brown mottlings in serious cases of waterlogging and of "rusty" concretions of iron oxide in other cases. These are invaluable guides to the nature and extent of the drainage deficiency even during dry periods. The causes of excessive drainage must be sought in the nature of the underlying geological material. The collection of economic data relating to the effect of natural drainage is proceeding, and it is important, in considering the value of a soil, to take into account the water circulation as well as the content of plant food.

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SOME DETRITALS OF THE GAULT

By H. H. Glasscock,
Department of Zoology and Geology.

The sample examined was obtained from a recently-dug pit in the Gault, at Naccolt, Wye, Kent. It was taken 15 feet from the surface of the soil and was treated for mineralogical examination within a few hours (i.e. before the clay had had time to dry).

Cakes of the sample were cut up into cubes and these were shaken in shaking bottles with very dilute ammonia for several hours in order to deflocculate the clay. The mineral grains, together with fossiliferous material, were separated from the colloidal substance and the very small clay particles by elutriation. The grains were dried in a steam oven and passed successively through ½ MM. and 100-mesh sieves, each separate being divided into four parts according to specific gravity, by flotation on heavy liquids. Portions of each of the final divisions were treated with dilute hydrochloric acid to remove the very abundant calcareous fossil debris which was present. Most of the grains which were untreated with hydrochloric acid were found to be free from ferruginous and other coating materials so that other treatment was not necessary. After mounting in oils of suitable refractive index, the grains were examined by the petrological microscope.

The portion which did not pass through the ½ MM. mesh consisted almost entirely of selenite, while the "lighter than quartz" part of the grains which passed through the 100-mesh sieve provided an almost pure sample of the tests of Foraminifera which were mostly stained brown. Rutile, apatite and monazite were noted only amongst the small grains (< 100-mesh) while the other minerals noted were also seen amongst the larger grains (100-mesh—½ MM.). Quartz, however, was far less abundant amongst the smaller grains.

The following minerals were determined:—

Pyrites. Common in microscopic nodules. Superficial alteration was sometimes seen, this was probably to limonite. The colour was pale brass yellow and the lustre metallic. [Some of the grains were weakly magnetic and may have been marcasite, the isomer of pyrites—" Distributed . . . in sedimentary rocks, where the sulphide has probably been precipitated from soluble salts of iron."—Lowry, T. M., 1922, *Inorganic Chemistry* [London: Macmillan], p. 762.]

Rutile. Very rare. Well formed prismatic grains with slightly rounded pyramidal terminations. In transmitted light the colour was foxy-red, in reflected light a metallic lustre was exhibited. Pleochroism was moderate.

Apatite. This was uncommon and appeared as very small rounded grains showing evidence of solution. They were translucent and grey in colour.

Calcite. Common. Small, well crystallized forms of various shapes. Translucent and colourless or white with a vitreous lustre. [" Deposited from solutions containing calcium bi-carbonate."—Lowry, p. 630. " Recrystallized from shell fragments."—Boswell, P. G. H., *Geol. Mag.*, June 1915, p. 255.]

Quartz. Very abundant. It occurred in numerous forms, sub-angular, irregular and rounded grains being noted. Both fluid and mineral inclusions were present, many grains containing much indeterminable, amorphous material. The grains were transparent and colourless, a few exhibiting undulose extinction.

Glauconite. Of fairly common occurrence as small globular masses translucent to opaque. The colours varied from green to blackish-yellow. [" Appears in oceanic deposits just beyond the limits to which mud is carried by the action of the currents and the waves of the shore, and which is the principal form in which potash and iron are precipitated from sea water."—Lowry, p. 762.]

Gypsum (Selenite). Abundant. This mineral formed the large majority of the grains which did not pass through the ½ MM. mesh of a sieve. Its appearance, however, was uncommon amongst grains of smaller size. It was present as fairly well-formed crystals which were transparent to translucent and mostly unstained. The grains were colourless to white. [Precipitated in the natural evaporation of sea water which contains 0·14%—" The formation of selenite is due to the decomposition of iron pyrites and the action of H_2SO_4 produced on the $CaCO_3$ of fossil shells, etc."—G. M. Davies, " Rocks and Minerals of the Croydon Regional Survey Area." Proc. and Trans. Croy. Nat. Hist. and Sci. Soc., 1915-16.]

Monazite. Only one grain of this mineral was distinguished. It was well-rounded and translucent. The colour was yellow and moderate pleochroism was exhibited.

Limonite. Of common occurrence as irregular earthy grains usually brownish-yellow or ocherous by reflected light. Superficial alteration of pyrites to this mineral was noticeably common. [" Limonite has probably been formed by the action of oxygen on ferrous bi-carbonate, and is therefore substantially identical with iron rust . . . like rust it contains unoxidized ferrous carbonate."—Lowry, p. 781. " Limonite occurs in secondary and recent formations, being formed by deposition from water or oxidation of carbonate . . . yellow ochre is an argillaceous variety containing basic ferric sulphate, silicates, arsenates, etc. . . . Yellow ochre is perhaps in most cases a deposit from water containing green vitriol derived from the oxidation of pyrites." Jukes and Geikie, *Manual of Geology* 3rd ed., p. 63. Haematite and limonite are present in Terra Rossa.—*fide* G. W. Robinson, *Soils*, 1932, p. 74.]

Flint. Not uncommon. Appears as fine-grained chalcedonic particles in a variety of shapes being apparently the pseudomorphs of fossil material.

Summary of Minerals Identified.

Cubic: Pyrites.

Tetragonal: Rutile.

Hexagonal and Rhombohedral: Apatite, calcite, quartz.

Monoclinic: Glauconite, gypsum, monazite.

Non-Crystalline: Flint, limonite.

The assistance and advice of Dr. Brade-Birks is gratefully acknowledged.

A DEFENCE OF THE *SOIL-SERIES* AND AMERICAN METHODS OF SOIL-CLASSIFICATION

By S. Graham Brade-Birks, D.Sc.

In the New Jersey system of soil classification the unit is the *soil-type* (the individual soil as a farmer would define it). This name is binomial and consists of a combination of a *soil-series* name and a class (textural) name (e.g. Wye loam, where " Wye " is the *soil-series* name and " loam" is the class (textural) name). (Lee, 1931, p. 31, Brade-Birks, 1931a, p. 115, 1931b, p. 127.)

The Soil-Series Defined.

The term *soil-series* is now well known and has been fully explained in this *Journal* by Lee (1931, p. 71), but it will be an advantage to define it here for clarity. Soils are grouped into *soil-series* when they agree in geological properties, in topography, natural drainage, in soil-profile characteristics and in climate. The present writer prefers to group the properties involved under eight heads, but other pedologists gather these same properties under slightly different headings. Lee (1931, p. 31) and Furneaux (1931, p. 121) condense them into five, but the properties included are the same. We can describe a *soil-series* as a group of soils agreeing in (i) the geology of their mineral constituents, (ii) origin, indicated as the reason for the occurrence of these constituents in their present situations (e.g. as a result of weathering from rocks *in situ*, transport by river water, deposition as rain-wash), (iii) colour, (iv) topography, (v) natural drainage, (vi) *soil-profile* (i.e. vertical section : its appearance and other properties), (vii) chemical reaction of the surface soil, (viii) climate. These eight points are not isolated characters without relationship to one another, but are in fact closely associated as may be illustrated by the instances of natural drainage, colour, and *soil-profile*. The conditions of natural drainage may be deduced from the examination of a *soil-profile* by the practised observer while colour (i.e. the colour of the surface soil) forms an integral part of the *soil-profile* itself. Inter-relationship of all the characters used in the establishment of a *soil-series* might similarly be indicated here, but these instances shall suffice. A perusal of recent papers on the soil, will at once indicate that the *soil-series* has come into pedology to stay.

Fears and Doubts Implied and Expressed.

In a survey of the College Farms at Wye where the geology shows much diversity, eleven *soil-series* were established (Brade-Birks and Furneaux, 1930) over an area of some six hundred acres, and for SE. England Lee (1931) listed thirty-four other *soil-series*. Furneaux (1932) in his study of the High Weald of Kent met with sixteen *soil-series*. In Romney Marsh, Cole and Dubey (1932), established eight *soil-series* for a number of soils which they studied and with these Dubey (1933) has again dealt in a recent paper. In the study of soils in Somerset Low (1931-1932) has established thirteen *soil-series* and just recently the same author (Low, 1933) has defined fourteen *soil-series* as a result

of his field work upon the soils of a comparatively small area in NW. Cheshire. These examples taken from recent papers by workers who have been associated with the present writer illustrate the fact that when the soils of the whole of England have been well studied the number of *soil-series* into which they will fall will be very great. One has heard doubts and fears implied and expressed about this multiplicity of *soil-series* and expedients have been suggested to reduce their number by some sort of combination. It is the emphatic opinion of the present writer that the fears and doubts are groundless and that while it may be possible, some day in the future when our knowledge of English soils is much riper than it is now, to combine the *soil-series* into larger groups no necessity for such a grouping has arisen yet.

Our modern attitude of mind towards the soil, in regarding it as a natural object, implies the individuality of a very large number of soil-units, the soils, or technically *soil-types*, which we group in *soil-series* : it is no new experience in the study of nature to find a large number of units. In chemistry large numbers of substances are known, but no chemist would suppose it expedient on that account to call two different substances by the same name to reduce the complexity of this diversity. It is true in biology: for example, there are over 3,000 species of beetles in the British Isles, but no entomologist will suggest that in order to avoid confusion in speaking of them three or four species should be combined and called by the same name.

In the case of soil studies there is no reason from experience to fear the establishment of a large number of readily recognizable units, especially when we remember the object of this system of naming our soils, which is their recognition again, wherever they may occur. Another point in this connection which should be borne in mind is that within the experience of the individual farmer it is unlikely that any extremely large number of *soil-series* will occur. It will only be when we take a very extensive area or the country as a whole that we shall meet with this large number of *soil-series* and then it will be comparable with large numbers of kinds of natural objects in every branch of study, minerals, rocks, fossils, geological strata, plants, animals, chemical substances; for wherever they are studied these great assemblages of different recognizable units are matters for the specialist to whom fine distinctions in remote fields must always be referred.

The Argument from Experience.

The system of soil-classification suggested by Lee (1931) has the great advantage that while it was developed in New Jersey (see Lee, 1926) by Lee, it was found by him to be applicable in south-east England (Lee, 1931, p. 71). All the workers associated with the present writer have accepted the principles of American methods of soil-classification and those who have employed them in the field are very satisfied. Every year adds to our experience and we see no reason to change the opinion we have held from our early employment of these methods. The present writer makes a strong appeal to every soil surveyor and investigator in the British Isles to employ the well-established New Jersey method of classification and he feels that he can do this because he is not trying to impose upon other investigators something he has invented or modified himself, but something from outside which from an increasing knowledge he has learned more and more to appreciate. The invention of new terms and modifications of the New Jersey system for use in this country, tend only towards insularity without any corresponding advantage in clarity or accuracy and in the opinion of the present writer these modifications are pernicious and inexcusable.

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NOTES AND BRIEF REVIEWS

The H.E.A. Year Book, Vol. I. Wye: Horticultural Education Association, 1932. Price 3s. 6d., post free.

The Editor states in his prefatory remarks that the Year Book is an attempt to review the more important aspects of modern horticultural progress. This object has been achieved with noteworthy success. The volume is filled with authoritative information presented in a manner that is very easily readable. All horticulturists—those engaged in the industry as well as those interested in the educational side of the subject —will find the book most interesting, suggestive and profitable.

The Association is to be congratulated on the excellence of this its first Year Book.

A.H.B.

"Soil Profile Studies of Romney Marsh Pastures." By J. K. Dubey. *Journal of the Ministry of Agriculture*, May 1933, pp. 131-140.

The latest contribution to the solution of the perennial problem of the Romney Marsh fatting pastures comes from the pedological side. Following up earlier work by Dr. S. G. Brade-Birks and Mr. Furneaux, Dr. J. K. Dubey* has now published in the *Journal of the Ministry of Agriculture* a most interesting and admirably illustrated account of the general problem and of the main soil-series identified by him in Romney Marsh. The establishment of soil-series is an essential step in the pedological study on any area but it would be unwise to confuse the reconnaissance with the main attack. Some of the nine soil-series recognized are quite obviously unsuited for giving first grade pastures but the problem of distinguishing between the better soils still remains.

The earlier workers concentrated their attention on pairs of closely adjacent pastures which differed widely in value. Dr. Dubey's map shows relatively few such pairs and several of these may readily be distinguished by the effect of clay subsoils or shingle on drainage. The same soil-series may carry pasture of different value, thus, in assigning nine soil-series to four grades of pasture it is found that only four series occur in a single grade, four occur in two grades and one even in three grades. A soil-series moves up to a better grade as its top horizon becomes deeper and it moves down as its drainage becomes either excessive or seriously impeded. The best soil is a deep, well-drained loam. Deviations sufficient to constitute new soil-series clearly prevent the formation of the best pastures but there is now a great need for detailed work to discover whether the finer differences can be identified by field study of the soil profiles or whether analytical work is needed. Are the more important practical differences found between series or within the same series (e.g. in the New Romney Series)? Future investigators will have the advantage of being able to eliminate those fields with soils shown by Dr. Dubey's work invariably to carry poor pastures and to proceed at once to the more direct attack on the problem of the better soil-series.

Dr. Dubey states that the management was fairly constant in the pastures studied and suggests that management may seriously affect fertility through its effects on the soil

* Dr. Dubey has previously collaborated in this *Journal* with Mr. L. W. Cole.—Ed.

profile as well as through its more immediate effects on the herbage. There can be no question about his final conclusion that " Climate, management, and drainage also affect pasture fertility and should be duly investigated in a pedological study."

E. M. Crowther.

The Apple. Sir A. Daniel Hall and M. B. Crane. London: Martin Hopkinson, 1933, pp. 235. 10s. 6d.

Since this work reached our hands only a few hours before going to press, it is clearly impossible to do justice in a hasty perusal of its contents. None will question the urgent need of a practical review of the extensive researches bearing on the problem of apple growing, which have been prosecuted at our Horticultural Research Stations with such conspicuous success in the last two decades. Fundamental contributions to knowledge of the practice of apple culture have been made, and it is the function of this book to draw them together for the practical grower.

It contains in Chapter IV an outstandingly valuable summary of the work of Mr. Crane and his colleagues at the John Innes Horticultural Institution on fertilization and fruit setting. Clear emphasis is laid on the potential problem of finding a satisfactory " pollenizer " for Cox's Orange. The existence of partial cross-incompatibility in the apple has not been previously brought out in this unmistakable fashion and growers will doubtless follow with interest, not unmingled with apprehension, the extent to which these views are confirmed by the cropping for instance of interplanted Ellison's Orange, Laxton's Perfection and Cox's Orange.

With regard to the cultural aspects we cannot escape a conviction that clearer direction could have been given in regard to certain research findings. This might with advantage have been accomplished at the expense of the particulars on such matters as the making of a field survey plan, budding and grafting, which are equally adequately treated of in other easily accessible works.

For instance in regard to manuring, the symptoms of deficiency of such constituents as potash or nitrogen could have been amplified to advantage. An insistence on the use of dung as the basis of manurial practice is cheerless counsel with the depleted supplies consequent upon farm and transport mechanization. We might well look for a broader discussion of possible substitutes. Of recommended rootstock varieties the details given are sparse and we are frankly incredulous of the statements to the effect that No. V and No. VI are amongst the best of their respective classes: surely the East Malling *dossier* suggests an unenviable reputation particularly in the case of No. V.

It is with such reflections as these that we temper our admiration for much that is valuable to grower and educationist alike.

R. T. Pearl.

Imperial Institute Annual Report, 1932. By the Director, Lt.-Gen. Sir William Furse, K.C.B., D.S.O., to the Board of Governors. London: Imperial Institute, 1933. 56 pp. 2s.

This report gives some indication of the wide usefulness of the Imperial Institute in its three branches: intelligence, laboratory investigation and education.

Many enquiries are, naturally, concerned with agricultural products; among nearly fifty enquiries relating to insecticidal plants were some relating to materials not yet on the market such as the African *Tephrosia Vogelii,* Haiari of British Guiana and

Cube of South America. In a case where freight charges from a farm in Kenya to the coast were high, particulars were supplied concerning the cultivation of plants yielding essential oils and the enquirer was put into touch with an interested firm. These are merely examples of usefulness which can be paralleled throughout this interesting and informative report.

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